PART G – Technical Specifications

City of Brentwood
Brentwood, California

FOR THE CONSTRUCTION OF THE

WASTEWATER TREATMENT PLANT EXPANSION – PHASE II

PROJECT NO. 592-59140

Volume 1 of 3
Technical Specifications Divisions 00 - 10

January 2020

In Association with

TJC and Associates, Inc.

Burks Toma Architects

Black and Veatch

RHAA Landscape Architects

SEMCO Consultants, Inc.

JDH Corrosion Consultants

Cal Engineering and Geology, Inc.

HYT Corporation

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Date
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DIVISION 08 – DOORS AND WINDOWS

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DIVISION 09 – FINISHES

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DIVISION 10 – SPECIALTIES

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DIVISION 11 – EQUIPMENT

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DIVISION 12 – FURNISHINGS – Not Used

DIVISION 13 – SPECIAL CONSTRUCTION

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CITY OF BRENTWOOD
Brentwood, California

WASTEWATER TREATMENT PLANT EXPANSION - PHASE II

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SECTION 01010 - SUMMARY OF WORK

PART 1 WORK COVERED BY CONTRACT DOCUMENTS

The Work of this Contract comprises all the work necessary to provide and install an expanded, renovated, and fully functional wastewater treatment plant. It includes modifications of existing wastewater treatment facilities and construction of new wastewater facilities, including process structures and buildings, roads, civil/sitework, and landscaping. The Work is within an operational wastewater treatment plant which is required to remain in reliable and safe operation throughout the entire contract period.

The Work includes the following principal elements:

1. Process Structures

    a. Activated sludge basin (Basin 3 and 4)
    b. Retrofit of existing oxidation ditches to diffused air
    c. Aeration blowers and Blower/Electrical/Maintenance Building
    d. Secondary Clarifier No. 3 and RAS Pump Station/Building
    e. Filter feed pump
    f. Chlorine contact tank modification
    g. WAS storage
    h. Biosolids dryer and building
    i. Dried solids storage building

2. Demolition of existing facilities

3. Site Development:

    a. Ground improvement
    b. Miscellaneous site work, roads, drainage, and landscaping
    c. Miscellaneous process and hydraulic structures
    d. Yard process piping system additions and modifications
    e. Utility service upgrade to 21 kV Primary Service
    f. Electrical power distribution, motor controls and site lighting
    g. Process instrumentation and control systems additions

PART 2 WORK SEQUENCE AND CONSTRAINTS

2.1 CONTINUITY OF PLANT OPERATIONS – GENERAL

Construction under this Contract involves modification of facilities at the existing operating wastewater treatment plant, which must continue to meet requirements of State and Federal regulating agencies.

This existing wastewater treatment plant is currently and continuously receiving and treating sewage and those functions shall not be interrupted except as specified herein. The Contractor shall coordinate the work to avoid any interference with normal operation of plant equipment and processes.

In addition to the requirements specified elsewhere in these Contract Documents, the Contractor is advised of the following constraints to the work sequence and schedule.

The Contractor shall note that not all valves and gates that may be used to isolate lines and facilities will completely seal. The Contractor shall allow for leakage in planning its work and may, with the Owner's concurrence, test certain valves and gates before work involving isolation is begun. Contractor shall assume that all existing valves 24 inch and greater will leak up to 50 gpm; all existing valves less than 24 inch will leak up to 25 gpm; all existing gates will leak up to 25 gpm; and Contractor shall manage flows from these leaking valves at no additional cost to the Owner. Contractor shall assume existing pipes and pipelines equal to or greater than 48 inch diameter will have joints that leak up to 100 gpm per joint and existing pipelines less than 48 inch diameter will have joints leaking up to 50 gpm per joint; Contractor shall assume that existing water holding structures will leak up to 50 gpm through joints and cracks; and Contractor shall manage flows from these leaking joints and cracks at no additional cost to the Owner. The Contractor shall provide adequate temporary pumping and piping facilities to clear the work areas as necessary of water, sewage and sludge. The Contractor shall clean the work areas as required to perform work.

Shutdown of existing facilities will be performed by Owner personnel or by the Contractor only under Owner supervision and with prior approval.

The work under this contract shall be conducted in a manner that will minimize shutdowns, roadway closures, or traffic obstructions caused by construction. Shutdowns causing damage to adjacent public and private property shall not be permitted and any damage resulting shall be the sole responsibility of the Contractor.

The Contractor shall note that only certain structures, tie-ins and constraints are addressed in this section. All work, whether or not addressed here, shall be governed by applicable parts of this section, and schedules and procedures shall be further submitted for approval.

Changes to existing utilities or any new connection thereto must be coordinated to provide the least possible interference with plant operations. Prior to any shutdown or flow diversion all materials, fittings, supports, equipment and tools shall be on the site and all necessary labor scheduled prior to starting any connection work.

The Contractor shall include all work described in this section in the construction schedule. The sequence and constraints identified in this section shall be followed in the construction of the work. However, alternatives to these sequences and constraints may be submitted by the Contractor for review by the Construction Manager.

a. Shutdowns are only permitted on Monday, Tuesdays, Wednesdays, or Thursdays unless otherwise approved by the Construction Manager. Such shutdowns are only permitted a maximum of once per week.

b. Shutdowns shall not be permitted during rainfall events and for a period of 24-hours after the occurrence of a rainfall event. A rainfall event shall be defined as 0.25 inches of rain or greater over any 24-hour period.

c. Where night shutdowns are specified or required, they shall take place only between the hours of 12:00 a.m. and 5:00 a.m., and shall not exceed 5 hours in a single shutdown, unless otherwise specified.

d. Shutdowns that may impact the daily permit sampling are prohibited.

To minimize impact on plant staff, all outages shall be limited to 8-hour periods, whenever possible -unless otherwise noted. Planned utility service shutdowns to any service area or process unit of the project shall be accomplished during periods of minimum use. In some cases, this will require night or weekend work, which shall be at no additional cost to the Owner. The Contractor shall program work so that service will be restored in the minimum possible time and shall cooperate with the Owner in reducing shutdowns of the utility to a minimum.

Planned electric power outages shall be permitted for a maximum of 6 hours unless otherwise approved by the Construction Manager. Contractor shall provide their own temporary standby generator suitably sized for supplying plant power during the 6-hour outage. The existing GEN-1 standby generator shall be verified by the Contractor to be operational throughout the construction outage period to serve as a standby power source should the temporary generator provided by the Contractor fail or otherwise become unavailable. Plant backup generator, GEN-1 shall not be used by the Contractor to provide plant process loads during the construction outage period.

Contractor shall note that the capacity of GEN-1 is insufficient for serving the entire plant process load and requires load shedding and load prioritization to maintain required plant operations during a utility outage. The Contractor shall provide sufficient temporary power capacity to provide full plant load and operation equivalent to support full plant operations as when under normal utility power. Detailed temporary power strategy prepared by the Contractor shall include supporting calculations in sufficient detail to allow confirmation that the temporary power scheme can maintain full plant loads and operation equivalent to normal utility power. Use of the plant load shedding or load prioritization strategies will not be allowed for the Contractor's temporary power strategy.

No utility shall be disconnected without prior written approval from the utility owner and Construction Manager. When it is necessary to disconnect a utility, the Contractor shall give at least two weeks notice or such advance notice as required by Contractor's coordination of outages necessary for utility upgrades (e.g., PG&E service upgrades) whichever is greater, to the utility owner and to the Construction Manager for approval of the proposed schedule.

The Contractor shall provide staff following shutdowns to monitor and ensure the proper operation of systems.

The Contractor is advised that any shutdown of facilities will place a considerable burden on the Owner's staff before, during and after the shutdown. If through inadequate planning, lack of preparedness, faulty or inefficient workmanship or other causes controllable by the Contractor, delays, excessive time, or additional shutdowns are required that cause the Owner to incur extra cost including any imposed regulatory fines, said extra cost will be assessed against the Contractor.

2.2 UNLAWFUL BYPASSING

A. Bypassing of untreated or partially treated sewage to surface waters or drainage courses is prohibited during construction. In the event accidental bypassing is caused by the Contractor's operations, the Owner shall immediately be entitled to employ others to stop the bypassing without giving written notice to the Contractor. If a Contractor-initiated bypass occurs, the Contractor shall pay all expenses incurred by

the Owner and any fines imposed by State and Federal agencies, courts, and third party suits.

2.3 SYSTEM OUTAGE PLAN AND REQUEST

Modifications to existing facilities, the construction of new facilities, and the connection of new to existing facilities may require the temporary outage or bypass of processes or facilities. In addition to the Construction Schedule, the Contractor shall submit a detailed outage plan for each required outage or bypass in accordance with Section 01340- Shop Drawings, Product Data and Samples and time schedule for all construction activities related to all outages or bypasses. Tables 1 and 2 define outage limitations and constraints for the existing utilities and pipelines.

The outage plans shall be submitted to the Construction Manager for the Owner's review and acceptance a minimum of two weeks in advance of the time that such outages are required.

A System Outage Request (SOR form located at the end of this section) shall accompany each outage plan. The outage plans shall be coordinated with the construction schedule and shall include the Contractor's planned method; the length of time required to complete said operation; and necessary temporary power, controls, instrumentation or alarms required to maintain control, monitoring and alarms; and the manpower, plant and equipment that the Contractor shall provide in order to ensure proper operation of affected facilities. In addition, the outage plan shall describe the Contractor's contingency plan that shall be initiated in the event that its temporary facilities fail or it becomes apparent that the time constraints described in the approved SOR cannot be met. The contingency plan shall conform to all specified outage requirements. All costs for preparing and implementing both the outage and contingency plans shall be borne by the Contractor.

The Construction Manager shall be notified in writing at least one week in advance of the required outage if the schedule for performing the work has changed or if revisions to the outage plan are required. Any changes must be approved by the Construction Manager and the Owner prior to the outage.

The Contractor shall attend a meeting with the Construction Manager and Owner one week before the scheduled outage to review the SOR.

Table 1 – System Outage Request Limitations/Constraints

Fluid Abbreviation	Process Fluid/System	SOR Limitations/Constraints			
		Seasonal	Shutdown Hours	Shutdown Length (hrs)	Other Shutdown Requirements
	Electrical Power			6	
A	AIR			8	
AA	AERATION AIR			4	
AL	ALUM			8	
BW	BACKWASH WATER			8	
CA	COMPRESSED AIR			8	
CD	CHEMICAL DRAIN AND VENT			24	
CLC	CHEMICAL LINE CONTAINMENT				Case by case basis.
CWR	COLD WATER RETURN			24	
CWS	COLD WATER SUPPLY			24	
D	DRAIN AND VENT			8	

Fluid Abbreviation	Process Fluid/System	SOR Limitations/Constraints			
		Seasonal	Shutdown Hours	Shutdown Length (hrs)	Other Shutdown Requirements
DW	DEMINERALIZED WATER			24	
DWS	DEWATERED SLUDGE			12	
FA	FOUL AIR/FRESH AIR		9pm - 5am	8	
FE	FINAL EFFLUENT			4	
FEF	FILTERED EFFLUENT			4	
FS	FROTH SPRAY			24	
FSP	FIRE PROTECTION SPRINKLER SYSTEM			4	
G	GRIT			24	
H	SODIUM HYPOCHLORITE				Case by case basis. Disinfection shall remain functional at all times, unless prior written approval is obtained for the City
HWR	DOMESTIC HOT WATER RETURN		5pm - 5am	12	
HWS	DOMESTIC HOT WATER SUPPLY		5pm - 5am	12	
IA	INSTRUMENT AIR			8	
IRR	LANDSCAPE IRRIGATION			24	
ML	MIXED LIQUOR		12am – 5am	3	
MLR	MIXED LIQUOR RECYCLE			8	
NG	NATURAL GAS		5pm - 5am	8	
OF	OVERFLOW				
PD	PUMPED DRAIN				
PEC	POLYMER				
PI	PLANT INFLUENT		12am – 5am	4	
PW	POTABLE WATER		5pm - 5am	4	
PCD	PUMPED CHEMICAL DRAIN			24	.
RAS	RETURNED ACTIVATED SLUDGE			8	
REW	RECLAIMED WATER			8	
RWL	RAINWATER LEADER			24	
S	SCUM			8	
SA	SAMPLE			24	
SB	SODIUM BISULITE				Case by case basis. Disinfection shall remain functional at all times.
SD	STORM DRAIN	Sept - May		8	
SE	SECONDARY EFFLUENT		12am – 5am	3 hours unless other arrangements are made.	
SF	SLUDGE FILTRATE			24	
SRP	SEPTAGE RECEIVING PIPE			24	
SS	SANITARY SEWER		5pm - 5am	4 hours unless other	

Fluid Abbreviation	Process Fluid/System	SOR Limitations/Constraints			
		Seasonal	Shutdown Hours	Shutdown Length (hrs)	Other Shutdown Requirements
				arrangements are made.	
UW	UTILITY WATER		9pm - 5am	4	
V	VENT				
WAS	WASTE ACTIVATED SLUDGE			8	
WW	FILTER WASTE WASHWATER			4	

Table 2 – System Outage Request for Specific Existing Pipelines

Pipeline	SOR Limitations/Constraints			
	Seasonal	Shutdown Hours	Shutdown Length (hrs)	Other Shutdown Requirements
36” ML		12am – 5am	3	
24” SE		12am – 5am	3	
30” SE bypass				No shutdown allowed. Require bypass pumping.

2.4 SPECIFIC SEQUENCE AND CONSTRAINTS

A. The Contractor shall note that only certain structures, tie-ins and constraints are addressed in this section. All work, whether or not addressed here, shall be governed by applicable parts of this section and schedules and procedures further submitted for approval. If work by the Contractor will require a longer shutdown than specified in Table 1 or Table 2, the Contractor shall provide temporary bypass pumping. in accordance with Section 02554, In-Plant Temporary Bypass Pumping.

B. The Contractor shall include all work described in this section in the construction schedule. The sequence and constraints identified in this section shall be followed in the construction of the work. However, alternatives to these sequences and constraints may be submitted by the Contractor for review by the Construction Manager. Specific sequencing constraints include the following:

1. Ground Improvements

   a. The Contractor shall identify and relocated any pipelines or utilities that may be impacted by ground improvement work. If necessary, the Contractor shall reroute or provide temporary pipelines as needed to perform the ground improvement work at no additional cost to the City.

   b. Ground improvement work shall be monitored by City during construction, including settlement monitoring and ground improvement testing during and after completion of the ground improvements. The Contractor shall coordinate with the City as required to accommodate inspection and testing by the City.

2. Oxidation Ditch, Aeration Basin and Blower Building Construction

   a. New Blower Building electrical infrastructure including duct banks, switchgear, motor control center, and ancillary distribution equipment installed, tested, and commissioned.

b. New temporary/interim power source from Switchgear B to the Blower Building Electrical Room sufficient for limited Aeration Basin operation is completed, tested, and energized. Limited Aeration Basin operation is defined as 2 duty and 1 standby blower.

c. Aeration Basins 3 and 4 and supporting Blower Building and Aeration Systems including new control system panels shall be constructed and on line and in service in their entirety, with all process equipment installed, commissioned, and successful functional and performance testing complete, prior to decommissioning either Oxidation Ditch. All remote monitoring via the plant SCADA system shall be fully tested and functional at the Central SCADA HMIs in the Control Building.

d. Both Aeration Basins 3 and 4 shall be brought on line and in service, with both Oxidation Ditch 1 and 2 in service, to the extent necessary for the City to determine consistent operations and treatment performance, but not more than forty-five (45) days following successful performance testing. A portion of the mixed liquor from Oxidation Ditch 1 and 2 can be transferred to Aeration Basins 3 and 4 for startup. The Contractor shall allow for up to 2 weeks for Aeration Basins 3 and 4 to stabilize with mixed liquor, prior to starting performance testing.

e. Two activated sludge process units, must be in service at all times. Oxidation Ditch 1 and Oxidation Ditch 2 each count as a single process unit. The combined capacity of Aeration Basin 3 and 4 together count as a single process (i.e. half capacity each).

f. Following Aeration Basin 3 and 4 acceptance of operations and treatment performance by the City, Aerations Basins 3 and 4 and Oxidation Ditch 1 will remain on line; and decommissioning, demolition, and construction of Oxidation Ditch 2 may commence.

g. New 21 kV PG&E service, new MVSG1 shall be constructed, tested, commissioned and energized; includes site engineering and approval of installation by PG&E.

h. New XFMR-2, new Switchgear D, and electrical duct bank to Blower Building shall be constructed, tested, commissioned and energized.

i. Oxidation Ditch 2 shall be constructed and on line in its entirety, with all process equipment installed, commissioned, and successful functional and performance testing complete, prior to decommissioning Oxidation Ditch 1.

j. Oxidation Ditch 2 shall be brought on line and in service, with Aeration Basins 3 and 4 and Oxidation Ditch 1 to the extent necessary for the City to determine consistent operations and treatment performance, but not more than thirty (30) days following successful performance testing. A portion of them mixed liquor from Aeration Basin 3 and 4 or Oxidation Ditch 1 can be transferred to Oxidation Ditch 2 for startup. The Contractor shall allow for up to 2 weeks for Oxidation Ditch 2 to stabilize with mixed liquor, prior to starting performance testing.

k. Following Oxidation Ditch 2 acceptance of operations and treatment performance by the City, Aerations Basins 3 and 4 and Oxidation Ditch 2 will remain on line; and decommissioning, demolition, and construction of Oxidation Ditch 1 may commence. A portion of them mixed liquor from Aeration Basin 3 and 4 or Oxidation Ditch 2 can be transferred to Oxidation Ditch 1 for startup. The Contractor shall allow for up to 2 weeks for Oxidation Ditch 1 to stabilize with mixed liquor, prior to starting performance testing.

3. 36” Mixed Liquor Pipeline Tie-in

a. The 36”-ML pipeline tie-in shall be completed prior to the performance testing and acceptance of Aeration Basins 3 and 4.

b. If more than 3 hours is required to tie-in the proposed 36” mixed liquor pipeline to the existing mixed liquor pipe connection, line stopping of the existing mixed liquor pipeline or bypass pumping may be required. The Contractor shall provide temporary bypass pumping in accordance with Section 02553, as needed.

c. If Aeration Basins 3 and 4 have been constructed and hydraulically tested prior to installation of the 36” ML pipeline, primary effluent from the Denitrification Splitter Box may be diverted and stored in Aeration Basins 3 and 4 for around 12 hours. After completion of 36”-ML pipe installation, primary effluent shall be pumped to the Denitrification Splitter Box. The Contractor shall provide obtain approval from the Engineer prior to diverting primary effluent to Aeration Basins 3 and 4. at a rate approved by the City.

4. 24” Secondary Effluent Pipeline Tie in

a. The 24” SE pipeline tie-in shall be completed prior to the performance testing and acceptance of Secondary Clarifier 3 and RAS Pump Station.

b. Two secondary clarifiers shall be in service at all times.

c. Following Secondary Clarifier No.3 acceptance of operations and treatment performance by the City, Secondary Clarifier 3 may be used to treat mixed liquor.

d. If more than 3 hours is required to tie-in the proposed 24” SE pipeline to the existing SE pipe connection, line stopping of the existing secondary effluent pipeline or bypass pumping may be required. The Contractor shall provide plugs, bulkheads and/or temporary bypass pumping in accordance with Section 02553 as needed.

e. If Aeration Basins 3 and 4 have been constructed and hydraulically tested prior to installation of the 24” secondary effluent pipeline, primary effluent from the Denitrification Splitter Box may be diverted and stored in Aeration Basins 3 and 4 for around 12 hours. After completion of 24”-SE pipe installation, primary effluent shall be pumped to the Denitrification Splitter Box at a rate approved by the City.

f. The Contractor shall submit the plan of performing the tie-in to the Construction Manager and obtain approval prior to beginning work.

5. Solids Dewatering

a. At least one belt filter press, associated dewatered sludge conveyor(s), and truck loading chutes must be available at all times.

6. Biosolid Dryer

a. Construction of the biosolids dryer building will require site and ground improvements between the Solids Handling Building and the Administration Building. The Contractor shall protect or reroute all existing pipelines and/or utilities, including temporary piping or pumping, required to maintain the existing functions of the Solids Handling Building and the Administration Building or any other impacted facility throughout construction.

b. The new 2" NG line and gas meter will be installed by PG&E during construction. The City will coordinate installation with PG&E. Contractor shall coordinate NG pipeline and meter installation and location with PG&E.

7. Chlorine Contact Tank

a. One chlorine contact tank (CCT) must be in service at all times. The City has the ability to shutdown flow through the CCTs for a maximum of 4 hours. All filtered effluent must be disinfected and shall pass through one CCT.

b. If longer duration is required to complete the work, flow can be diverted to existing Storage Pond No. 6 for a maximum of 3 days. If more than one shutdown is required, the Contractor shall provide 3 weeks between shutdowns to allow sufficient time to drain existing Storage Pond No. 6.

c. If a shutdown longer than 3 days required, pipe plugs, temporary bulkhead or bypass pumping may be required. Bypass pumping shall be provided in accordance with Section 02553.

8. Use of Plant Effluent Water for Construction and Testing

a. The Contractor may use Plant effluent for construction and testing to the extent it is available. On a limited basis to the extent available the Contractor may use the existing plant utility water distribution system such as hose connections for work on existing facilities. At no time shall the Contractor use more than 100 gpm of plant utility water unless a specific request has been approved by the Construction Manager.

9. Contractor Return Flows to the Plant.

a. The Contractor may, upon specific event approval from the Construction Manager, return water and sewage that are generated from such activities as draining existing process tanks, emptying pipes, and releasing of testing water. The discharge location of the return flow shall be approved by

Owner. Return flows may need to be pumped by Contractor supplied equipment. In no case shall this return of flow make the total plant flow exceed 8 mgd.

10. Testing and Startup

    a. Testing and startup of new equipment, with the exception of the early occupancy items identified in Section 3.0, shall not begin until completion of new PG&E service in approximately first quarter 2019.

2.5 ELECTRICAL SEQUENCING AND CONSTRAINTS

A. General: The following description is a possible sequence of work for electrical work that meets the specified constraints. Where possible, the sequence steps shall be performed simultaneously. Contractor shall prepare a detailed scope of work coordinated with other trades that meets all constraints and schedule requirements for the work performed under this Contract.

B. Electrical Service Sequencing

1. Submit shop drawing submittals for new PG&E service equipment including 21 kV switchgear, protective relaying, batteries, and other requirements as specified and as required under the PG&E Primary Service Rules (Rule 21). Receive favorable review from the Owner and PG&E.

2. Coordinate and facilitate a site meeting with PG&E, the Engineer, the Electrical Subcontractor, and Owner to review PG&E requirements, review and schedule new service infrastructure upgrade work to be performed by the Contractor, and review and schedule new service infrastructure work to be performed by PG&E. Refer to Section 16000.

3. Submit a detailed temporary power system design including quantities and minimum rating of temporary standby power generators, duration of operating time, alarm or indication, cabling requirements, location and electrical system connection points, and other equipment necessary to provide adequate temporary power to processes specified herein. Receive favorable review from Engineer.

   See the electrical drawings for the interim power feed to serve the Aeration Basin renovation and allow the Aeration process improvements to be completed prior to revisions to the Plant's utility service and new distribution equipment. Incorporate the interim feeder shown on the Drawings into the Contractor's temporary power scheme.

4. In addition, note that as specified above, the existing generator GEN-1 standby generator shall be verified by the Contractor to be operational throughout any construction outage period to serve as a standby power source should the temporary generator provided by the Contractor fail or otherwise become unavailable. Plant backup generator, GEN-1 shall not be used by the Contractor to provide plant process loads during the construction outage period. Note that the capacity of GEN-1 alone is insufficient for the entire plant load and requires load shedding and load prioritization to maintain plant operations during a utility outage. The Contractor shall provide sufficient temporary generator capacity to provide full plant load to achieve full plant operations equivalent to that when

powered under normal utility power. Detailed temporary power strategy prepared by the Contractor shall include supporting calculations in sufficient detail to allow confirmation that the temporary power scheme can maintain full plant loads and operation equivalent to normal utility power. Use of the plant load shedding or load prioritization strategies will not be allowed for the Contractor's temporary power strategy. Submit shop drawing submittals for other electrical distribution equipment required for the new process improvements and startup of the initial process systems including XFMR-N, XFMR-S, Switchgear D, MCC D3, standby generator GEN-2, and other equipment. Receive favorable review from the Engineer.

5. Submit shop drawing for control panels 27-CP-01, 27-MCP-01, 34-CP-01, and 51-CP-01 to support initial process improvements described above. Coordinate programming approaches and standards with latest City requirements at initial control system coordination workshops. Refer to Section 13400 and Section 13550.

6. Install new PG&E primary system pole riser, handholes, and underground ductbanks from designated PG&E service pole to the vicinity of the new MVSG1 Building.

7. Install new internal plant underground electrical infrastructure including handholes, underground ductbanks, and conductors/fiber optic cables from the vicinity of the new MVSG1 Building to the new Blower Building, Aeration Basins, Oxidation Ditches, RAS Pump Station, WAS Storage facility, and other new or upgraded process areas.

8. Install new Blower Building electrical distribution and Aeration control equipment. Test and commission new equipment using temporary portable power sources for control and testing power.

9. Install new Blower Building fiber optic control network cable and connect to existing PLC network as shown on the Drawings. Fabricate, program PLCs, configure HMI modifications, Factory Test, install, and perform Operational Readiness Test for new control panels 27-CP-01 and 27-MCP-01 per Section 13400 and Section 13550.

10. Construct new conduit and conductors to Blower Building from spare breaker in SWGR-B to Aeration Building Electrical Room. Provide temporary conductors from SWGR-B via existing spare conduits as shown on the Drawings to serve initial Aeration Loads consisting of one (1) Aeration Blower along with all Basin mixers and ancillary loads for operating both Aeration Basins 3 and 4.

11. Complete electrical studies per Section 16080 and establish interim and final protective relay settings coordinated with PG&E short circuit and protective device information. Submit final settings study to Owner and PG&E for review and receive favorable review. Complete PG&E Form DG-5 with final approved protective device settings.

12. Construct and install new standby generator, GEN-2. Construct new main service electrical equipment pad including new conduit risers and install new MVSG1, XFMR-S, XFMR-N, and SWGR-D.

13. Receive final O&M manuals for electrical equipment for use in testing and startup.

14. Connect GEN-2 to SWGR-D. Make protective relay settings at MVSG-1 and SWGR-D per the approved protective study and DG-5 form. Establish control system network connectivity between electrical distribution equipment and plant SCADA. Test and commission new equipment.

15. Construct new conduit and conductors from new XFMR-N to new Cable Tap Box at Screening and Grit Handling Building wall. Install new bus duct to vicinity of existing bus duct entrance to Electrical Room.

16. Coordinate installation of new PG&E primary and feeder conductors by PG&E from riser pole to MVSG1 utility section. Terminate conductors at MVSG1 but do not terminate at PG&E riser pole (PG&E conductors not energized).

17. Install new WAS Storage distribution equipment, and MCC D3. Test and commission new equipment using temporary power sources for control and testing power.

18. Fabricate, program PLCs, configure HMI modifications, Factory Test, install, and perform Operational Readiness Test for new control panels 34-CP-01, and 51-CP-01 per Section 13400 and Section 13550. Revise and update existing control panels and HMI systems modified under this Contract.

19. Coordinate equipment inspection by PG&E; receive approval from PG&E of equipment settings in compliance with Rule 21 and DG-5 form.

20. Complete final switchover of PG&E service. Work shall occur simultaneously where possible. Existing process outages, power outages, and other constraints shall be met as specified herein:

    a. Provide temporary generator supplies to existing processes fed from SWGR-B
    b. De-Energize existing 480V service
    c. De-energize existing photovoltaic source
    d. Isolate SWGR-B main bus
    e. Remove temporary Aeration System feeders from SWGR and reterminate to new SWGR-D feeder for full capacity Aeration System
    f. Coordinate 21KV conductor terminations on PG&E riser pole by PG&E
    g. Demolish existing bus duct connection to existing SWGR-B
    h. Complete new bus duct connection to SWGR-B
    i. Energize XFMR-S and SWGR D via MVSG1; remove temporary generators
    j. Re-energize system and SWGR-A through new XFMR-N via MVSG1; remove temporary generators
    k. Re-energize photovoltaic system

21. Demolish existing PG&E service and remove existing padmount transformer and abandoned busduct hardware.

22. Startup, test, and commission Dryer, WAS Storage, RAS Pump Station, remaining Aeration Basin, Oxidation Ditches, and other process loads served from SWGR-D as specified.

C. Other Electrical Work

1. Following energization of the new PG&E service, subsequent process work at the plant shall be as determined by the Contractor's overall construction schedule subject to the electrical outage and other constraints as specified herein.

2.6 PLANT ACCESS

A. Continuous access to the treatment plant facility shall be provided at all times during the project. Such access shall be suitable for large vehicles, e.g. chemical delivery and sludge hauling trucks. Plant access routes shall be provided as detailed on the Contract Plans unless alternative plans are submitted by the Contractor and approved by the Owner. The Contractor will be responsible for providing any temporary signage and controls to notify of this traffic routing.

2.7 ENVIRONMENTAL MITIGATION MEASURES

A. The Contractor shall comply with all the mitigation measures included in the *Initial Study / Proposed Mitigated Negative Declaration City of Brentwood Wastewater Treatment Plant Expansion Phase II*, dated May 2016.

B. Where conflicts arise between the attached Mitigation Measures and other requirements of the Contract Documents, the attached Mitigation Measures shall prevail. A copy of the Initial Study / Proposed Mitigated Negative Declaration is available at the Owner's office for review.

IS/MND Mitigation Measures

Mitigation Measure	Item	Requirement
BIO-1	General Construction Measures	All contractors and equipment operators will be made aware of the ecological values of the site, and will be given instructions to comply with all mitigation measures. Construction activities will be limited to a designated work area (including the work corridor and staging areas). The work area will be clearly identified and will be staked and flagged where necessary prior to initiation of construction activities. This will include flagging of riparian and wetland habitats in the vicinity of work areas to ensure their avoidance and protection. All construction activities, including site preparation and development, will be restricted to daytime hours between 7 a.m. and 5 p.m. on weekdays and non-holidays unless weekend work is unavoidable.
BIO-3	Special-Status Plants	On suitable land cover types under the East Contra Costa County Habitat Conservation Plan (ECCCHCP), the City will conduct special-status plant surveys using approved CDFW/USFWS methods during the appropriate season for identification of covered and no-take plant species, as well as any additional special-status plant species not covered under the ECCCHCP. If ECCCHCP-covered special-status plant species are found in the construction areas, the Contractor shall implement all applicable conditions on covered activities under the ECCCHCP including Conservation Measure 1.11 “Avoid Direct Impacts on Extremely Rare Plants” and Conservation Measure 3.10 “Plant Salvage when Impacts are Unavoidable.” A copy of the ECCCHP can be accessed at http://www.co.contra-costa.ca.us/depart/cd/water/hcp/archive/final-hcp-rev/final_hcp_nccp.htm
BIO-4	Special-Status Amphibians and Reptiles	The City will implement pre-construction surveys, as necessary per the ECCCHCP, for California tiger salamander, silvery legless lizard, western pond turtle, California horned lizard, giant garter snake, and San Joaquin whipsnake in annual grassland habitat for the construction areas at the WWTP. If any ECCCHCP -covered species are found (California tiger salamander, silvery legless lizard, western pond turtle, and giant garter snake), all applicable avoidance and minimization measures, construction monitoring, conservation measures, and/or mitigation fees of the ECCCHCP will be implemented. If any special-status species not covered by the ECCCHCP (California horned lizard and San Joaquin whipsnake) are discovered, measures to reduce impacts to less-than-significant levels would be developed in consultation with CDFW.

Mitigation Measure	Item	Requirement
BIO-5	Burrowing Owls	The City will implement pre-construction surveys for burrowing owls or burrows at proposed construction sites with potential habitat in accordance with methods described in Section 6.4.3 of the ECCCHCP. If the burrowing owls nests or burrows are discovered in the work areas, all applicable avoidance and minimization measures, construction monitoring, conservation measures, and/or mitigation fees for this species in the ECCCHCP will be implemented.
BIO-6	Other Special-Status Birds	If construction activities are scheduled to occur between February 15 and September 15, preconstruction surveys will be conducted at proposed construction sites within 30 days prior to any such activities to determine whether any nests of special-status birds are present. A qualified biologist will search within 1000 feet of sites for raptor nests, and within 250 feet of sites for passerine nests. Biologists will conduct a visual and aural search of the survey area on foot, using binoculars to scan tree tops for the presence of raptor nests. If any nests are identified, measures to reduce impacts to less-than-significant levels, such as species-specific buffers, would be developed in consultation with appropriate resource agencies (CDFW and/or USFWS).
BIO-7	American Badger	The City will implement pre-construction surveys for American badgers or burrows at proposed construction areas with potential habitat in conjunction with burrowing owl surveys. If any American badgers or burrows are found, measures to reduce impacts to less-than-significant levels would be developed in consultation with CDFW, and/or mitigation fees for this species in the ECCCHCP will be implemented.
CULT-1	Accidental Discovery of Archaeologic al Resources	If any prehistoric or historic artifacts, or other indications of archaeological resources such as unusual deposits of stone, bone or shell, stone artifacts, or historic trash deposits or foundations are discovered once ground-disturbing activities are underway, the Contractor shall stop work and notify the Construction Manager immediately. The find(s) shall be immediately evaluated by a qualified archaeologist provided by the Owner. If the find is determined to be a historical or unique archaeological resource, contingency funding and a time allotment to allow for implementation of avoidance measures or appropriate mitigation shall be made available, as provided in §15064.5 of the CEQA Guidelines. Work may continue on other parts of the project site while historical or unique archaeological resource mitigation takes place on-site.

Mitigation Measure	Item	Requirement
CULT-2	Accidental Discovery of Paleontological Resources	A qualified professional paleontologist provided by the Owner shall periodically monitor excavations to check for fossils that may be unearthed. The Contractor shall make provisions to allow access for inspections. If vertebrate fossils (e.g., teeth, bones) are unearthed by the Contractor anywhere on the project the Contractor shall notify the Construction Manger immediately. The finds shall be set aside and all excavation activity cease at the specific place of discovery until the paleontologist has assessed the find and, if deemed significant, salvaged the find in a timely manner. The decision to conduct paleontological salvage operations will be determined by the paleontologist in consultation with City staff. Work may proceed on other parts of the project while assessment and/or salvage by the paleontologist is underway. Finds determined significant by the paleontologist shall be conserved and deposited with a recognized repository such as the University of California Museum of Paleontology.
CULT-3	Accidental Discovery of Human Remains	In the event of the accidental discovery or recognition of any human remains, the Contractor shall notify the Construction Manager immediately. There shall be no further excavation or disturbance of the find or any nearby area reasonably suspected to overlie adjacent human remains, until compliance with the provisions of §15064.5(e)(1) and (2) of the CEQA Guidelines has occurred, as described below. The Guidelines specify that in the event of the discovery of human remains other than in a dedicated cemetery, the Contra Costa County Coroner must be notified to determine if an investigation into the cause of death is required. If the coroner determines that the remains are Native American, then, within 24 hours, the coroner must notify the Native American Heritage Commission, which in turn will notify the most likely descendant who may recommend treatment of the remains and any grave goods. If the Native American Heritage Commission is unable to identify a most likely descendant or the most likely descendant fails to make a recommendation within 24 hours after notification by the Native American Heritage Commission, or the landowner or his authorized agent rejects the recommendation by the most likely descendant and mediation by the Native American Heritage Commission fails to provide a measure acceptable to the landowner, then the landowner or his authorized representative shall rebury the human remains and grave goods with appropriate dignity at a location on the property not subject to further disturbances.
HWQ-1	Implement Construction BMPs for Water Quality Protection	The City shall obtain authorization of project construction activities under the SWRCB's NPDES Construction General Permit (Order No. 2009-0009-DWQ/NPDES Permit No. CAS000002, and any applicable amendments), for any activities not subject to exemption from the permit. The Stormwater Pollution and Prevention Plan (SWPPP) prepared for permit will describe the BMPs that will be used to avoid and minimize potential construction-related contaminant discharges at construction sites. Compliance with this mitigation shall be the responsibility of the Contractor. The Contractor will be responsible for ensuring that the construction is implemented in accordance with the Construction General Permit.

Mitigation Measure	Item	Requirement
NZ-1	Minimize Construction-Related Noise	To reduce noise-related impacts to occupants of nearby residential land uses, the following BMPs will be incorporated into the plans and design of the Proposed Project: Noise-generating construction activities will be limited to the weekday and weekend restrictions specified by the City's Municipal Code (Brentwood Municipal Code 9.32.050 – PROHIBITED SPECIAL NOISE SOURCES) http://www.brentwoodca.gov/civicax/filebank/blobdload.aspx?blobid=27737. All construction equipment shall have sound-control devices no less effective than those provided on the original equipment. No equipment will have an unmuffled exhaust system. The Contractor shall implement additional noise-reduction measures as practical, including but not limited to: (a) locating staging areas and stationary construction equipment as far away from sensitive receptors as feasible and direct noise emissions away from receptors; (b) limiting equipment idling time; and, (c) notifying nearby residents 48 hours in advance of starting construction in an area not previously affected by recent construction activities. The Contractor shall have a designated "noise disturbance coordinator" who will be responsible for responding to noise complaints, determining the causes of the noise, and instituting reasonable measures (as warranted) to correct the problem.

PART 3 EARLY OCCUPANCY OF PORTIONS OF WORK

3.1 The Contractor shall Substantially Complete the following portions of Work for Owner's occupancy including specified testing, training of Owner's personnel, and other preparations necessary for Owner's occupancy or use, by the date specified:

Facility	Calendar Days from Notice to Proceed
Milestone 1: New 21kV electrical service and power distribution, Aeration Basin 3 & 4: Full Process Capacity: Aeration Basins 3 and 4, Blower Building, and all associated equipment, piping, electrical distribution/motor control, control systems, and other ancillary components and systems necessary, when integrated with the above systems, for the new facilities to provide the full process treatment function.	520
Milestone 2: Remainder of the Work	900

3.2 Certificates of Substantial Completion will be executed for each designated portion of Work prior to Owner occupancy. Such certificate of Substantial Completion will describe the portion of the Work to be occupied by Owner, items that may be incomplete or defective, date of occupancy by Owner, and other information required by Owner and Contractor.

3.3 After Owner occupancy, allow access for Owner's personnel, access for others authorized by Owner, and Owner operation of equipment and systems.

3.4 Following Occupancy, Owner will:
1. Pay for power to operate equipment and systems.
2. Repair damage caused by Owner's occupancy, which is not a result of the Contractor's work.

3.5 Guarantee correction period for portions of the Work occupied or partially utilized by Owner shall commence with date of Substantial Completion for that portion of the Work and acceptance for use by Owner. Progress payment withholdings for portions of the Work occupied by Owner will not be released until final acceptance of the total Work.

3.6 Prior to such occupancy or use, enter into agreement with Owner indicating work that remains to be performed in occupied areas.

3.7 When Owner's use of occupied facilities reveals defective work, the Contractor shall correct defects.

3.8 Failure to achieve the Milestone 1 by the date specified in Section 3.1 shall result in assessment of liquidated damages in accordance with Article 5.4 of the General Conditions.

PART 4 OWNER FURNISHED MATERIALS

4.1 NONE.

PART 5 TRENCH EXCAVATION

Trench excavation shall be performed in accordance with Section 02200 – Earthwork.

PART 6 WORK UNDER OTHER CONTRACTS

6.1 Owner, utilities, and others may perform activities within Project area while the Work is in progress. Schedule the Work with Owner, utilities, and others to minimize mutual interference.

6.2 Activities by others which may affect performance of work include:

1. Construction of a Non-Potable Water Storage Tank and Pump Station (shown as existing on the Drawings) will be on-going to during the first year of construction of the Phase II Expansion. Contractor shall coordinate with the City to avoid construction and work conflicts during construction.

2. Construction of a new Maintenace Facility west of the existing Headworks/Solids Handling Building will be on-going during construction. This work is not located within the main treatment plant area, therefore construction impacts are expected to be minimal, however on-site traffic and access may be impacted.

3. Chemical deliveries, septage receiving, and other deliveries must be accommodated by the Contractor.

4. Construction of Security Project that includes widening of the East Access Road at the treatment plant. Work on the proposed Secondary Effluent line to shall not be concurrent with this project. Contractor shall coordinate with the City to avoid construction and work conflicts during construction.

PART 7 UNDERGROUND FACILITIES

The Contractor shall exercise care in all excavations to avoid damage to existing underground facilities. This shall include potholing and hand digging or vacuum excavation in those areas where underground facilities are known to exist until they have been sufficiently located to avoid damage to the facilities.

The Contractor shall exercise care in maintaining those pipes and facilities to be abandoned and/or removed which are required for the continuing operation of the existing facilities until such time as they can be abandoned. The Contractor shall exercise extreme caution in working in any area adjacent to existing facilities. It is essential that the existing facilities be maintained in service until the new work is ready for full time operation and is placed in service.

No additional compensation shall be provided the Contractor for compliance with the provisions of this section for the damage and repair of such facilities due to the lack of care.

For work at the treatment plant, the Contractor is responsible for coordinating all existing project documentation, including but not necessarily limited to, the Contract Documents and existing record drawings for the determination of the location of all underground facilities. If the Contractor determines that existing facilities interfere with the new Work and such facilities were not shown or were incorrectly shown in the Contract Documents, the Contractor shall notify the Construction Manager in accordance with Section 3.1 of the General Conditions.

PART 8 PROJECT SIGN

8.1 PROJECT SIGN REQUIREMENTS

A. The Contractor shall provide, install and maintain for the duration of the project a project sign as designated below. The sign shall be installed within three (3) days of Notice to Proceed and shall be installed where directed by the Construction Manager.

1. 8’ X 4’ exterior grade plywood, minimum ¾” thick.

2. Two coats exterior quality paint for background; one coat exterior quality paint for lettering.

3. Erect supports and framing on secure foundation, rigidly braced and framed to resist loadings. Install sign surface plumb and level; anchor securely.

4. Colors of sign shall be as designated by the Construction Manager.

5. Remove sign at end of project.

8.2 CONTENTS OF PROJECT SIGN

Project Name: Wastewater Treatment Plant Expansion – Phase II

Owner: City of Brentwood

Construction Manager: _ Psomas

Design Consultant: _Woodard & Curran

Contractor: _____

Start Date: _____

Estimated End Date: _____

PART 9 ACCESS FOR OPERATING PERSONNEL

The Contractor's attention is drawn to the fact that during the course of the work of this Contract, adjacent existing facilities will be used and maintained by Owner personnel. The Contractor shall coordinate its work in such a way as to interfere as little as possible with the routine work at existing facilities except in direct pursuit of the work of this Contract and as approved by the Construction Manager. The Contractor shall provide safe access at all times to all existing facilities for operating personnel and equipment.

CITY OF BRENTWOOD
SYSTEM OUTAGE REQUEST

SOR No. _____

	Date:
	Project::
To: CM	Requested By:
CM Firm	Name:

1. A Shutdown is requested on the following system:

2. Proposed date of Shutdown:

3. Estimated duration: Hrs. Beginning at _____ A.M. P.M.

4. Reason for Shutdown:

5. Operations staff assistance required: Yes No
Describe:

6. Method of Approach/Sequence of Events:

7. Equipment to be used during Shutdown:

8. Contingency Plan:

CITY OF BRENTWOOD

Wastewater Treatment Plant Expansion – Phase II
Project No. 592-59140
SOR REVIEW

SOR No. _____

Item: _____

Construction Manager Comments:

Construction Manager Signature: _____ Date: _____

Date Transmitted to OWNER: _____

Owner Comments:

Owner Engineering:_____ Date:_____

Owner Operations: Date: _____

Owner Maintenance: _____ Date: _____

Date Transmitted to Construction Manager: _____

SOR Acceptable with Comments Noted: _____

SOR Not Acceptable/Resubmit: _____

Date Construction Manager Transmits to Contractor: _____

END OF SECTION

SECTION 01025 - MEASUREMENT AND PAYMENT

PART 1 MEASUREMENT AND PAYMENT

1.1 GENERAL

Measurements of the completed work shall be in accordance with, and by instruments and devices calibrated to United States Standard Measures and the units of measurement for payment, and the limits thereof, shall be made as shown on the Plans, Specifications, General Requirements, and Supplementary Conditions.

1.2 UNITS OF MEASUREMENT

Measurements shall be in accordance with U.S. Standard Measures. A pound is an avoirdupois pound. A ton is 2,000 pounds avoirdupois. The unit of liquid measure is the U.S. gallon.

1.3 CERTIFIED WEIGHTS

When payment is to be made on the basis of weight, the weighing shall be done on certified platform scales, or when approved by the Construction Manager, on a completely automated weighing and recording system. The Contractor shall furnish the Construction Manager with duplicate licensed weighmaster's certificates showing the actual net weights. The City will accept the certificates as evidence of the weights delivered.

1.4 METHODS OF MEASUREMENT

Materials and items of work which are to be paid for on the basis of measurement shall be measured in accordance with the method stipulated in the particular sections involved. In determining quantities, all measurements shall be made in a horizontal plane unless otherwise specified.

Material not used from a transporting vehicle shall be determined by the Construction Manager and deducted from the certified tag.

When material is to be measured and paid for on a volume basis and it would be impractical to determine the volume, or when requested by the Contractor in writing and approved by the Construction Manager in writing, the material will be weighed and converted to volume measurement for payment purposes. Factors for conversion from weight measurement to volume measurement will be determined by the Construction Manager and shall be agreed to by the Contractor before such method of measurement of pay quantities will be adopted.

Full compensation for all expense involved in conforming to the above requirements for measuring and weighing materials shall be considered as included in the unit prices paid for the materials being measured or weighed and no additional allowances will be made therefor.

Quantities of material wasted or disposed of in a manner not called for under the Contract; or rejected loads of material, including material rejected after it has been placed by reason of failure of the Contractor to conform to the provisions of the Contract; or material not unloaded from the transporting vehicle; or material placed outside the lines indicated on the plans or given by the Construction Manager;

or material remaining on hand after completion of the Contract, will not be paid for and such quantities will be deducted from the final total quantities. No compensation will be allowed for hauling rejected material.

PART 2 BID ITEMS

The Bid Amounts for each Bid Item will be used for comparative bid analysis. The Bid amounts will also form the basis of monthly progress payments. Each Lump Sum bid amount will undergo further breakdown as described later in this section. Unit prices for any unit price bid items will be the basis for monthly progress payment determinations and for any changes related to that Work item. Bid Item 2 will also demonstrate the Contractor's compliance with the California Labor Code relating to the price for sheeting, shoring, and bracing of excavations. Bid items are not intended to be exclusive descriptions of work categories and the Contractor shall determine and include in its pricing all materials, labor, and equipment necessary to complete each Bid Item as shown and specified.

Sole Source Bid Items

The scope and lump sum cost for bid items defined as "Sole Source Bid Items" below is defined by manufacturer/vendor Quotations, which are included in Appendix B to these specifications. The Bidder will be responsible for contracting with the vendor/supplier identified to supply the full scope of materials and services defined in the Quotation. Substitutions are not allowed. Further, the Bidder shall be responsible for review of the Quotation to determine what additional work, if any, may be required to provide a complete and fully functional system. Where applicable, this work shall be included in the bid item identified for each Sole Source Bid Item below.

BASE BID – Bid Items 1 through 16

The Base Bid includes Bid Items 1 through 16, as described below.

BID ITEM 1: Mobilization/Demobilization – Lump Sum

Includes preparatory work and operations, including, but not limited to, those necessary for the movement of personnel, equipment, supplies and incidentals to the project site, for the establishment of all offices, buildings and other facilities necessary for work on the project, and for all other work and operations which must be performed or cost incurred prior to beginning work (Public Contract Code § 10104) and demobilization from the project site. Mobilization/Demobilization may not exceed 5% of the Contractor's total bid amount. Payment for mobilization and demobilization will be made at the bid price in the Bid Schedule under Bid Item 1, which price shall constitute full compensation for completion of all such work as required per the Contract Documents.

BID ITEM 2: Sheeting, Shoring, and Bracing- Lump Sum

Bid Item 2 includes all costs for planning, design, engineering, furnishing, construction and the removal and disposal of all temporary sheeting, shoring, and bracing as required but not limited to the provisions of any permits, and in accordance with the requirements of OSHA and the Construction Safety Orders of the State of California, pursuant to the provisions of Section 6700 through 6708 of the California Labor Code.

Groundwater will be present in trench and structure excavations. Contractor shall design shoring and dewatering systems to mitigate impacts from groundwater on excavations.

Payment for sheeting, shoring, and bracing or equivalent method shall be by unit of measure: lump sum (LS), which price named in the Bid Sheet under this Item shall constitute full compensation for

completion of all such Work as required per the Contract Documents. Payment will be made for the Work completed in proportion to the total value of the work for this bid item.

BID ITEM 3: Activated Sludge Basins 3 and 4 – Lump Sum

Bid Item 3 includes, but is not limited to, payment for all work associated with Activated Sludge Basins 3 and 4 including furnishing, installing, and testing of structural concrete, mixers, pumps, diffusers, gates, grating, handrails, piping, valves, supports, electrical, instrumentation and control, and site work, including structural excavation, dewatering, subgrade preparation and backfill, to provide a functional and operational system in accordance with the Contract Documents. Activated Sludge Basins 3 and 4 are typically shown on drawings starting with process area number "23", and also on drawings C-23 and C-28.

Bid Item 3 excludes all work included under Bid Item 15. It shall be the Contractor's sole responsibility to confirm the scope of Bid Item 15 against the scope of Bid Item 3 to avoid duplication of supply and services.

Payment for Activated Sludge Basins 3 and 4 will be made at the bid price in the Bid Schedule under Bid Item 3, which price shall constitute full compensation for completion of all such work as required per the Contract Documents.

BID ITEM 4: Retrofit of Oxidation Ditch No. 1 and No. 2 - Lump Sum

Bid Item 4 includes, but is not limited to, payment for all work associated with retrofitting Oxidation Ditches No. 1 and No. 2 including demolition of existing facilities and furnishing, installing, and testing of structural concrete, mixers, pumps, diffusers, grating, handrails, walkways, piping, valves, supports, electrical, instrumentation and control, and site work to provide a functional and operational system in accordance with the Contract Documents. Retrofit of Oxidation Ditch No. 1 and No. 2 are typically shown on drawings starting with process area number "21" and "22", and also on drawings C-22 and C-27.

Bid Item 4 excludes all work included under Bid Item 15. It shall be the Contractor's sole responsibility to confirm the scope of Bid Item 15 against the scope of Bid Item 4 to avoid duplication of supply and services.

Payment for retrofitting Oxidation Ditches No. 1 and No. 2 will be made at the bid price in the Bid Schedule under Bid Item 4, which price shall constitute full compensation for completion of all such work as required per the Contract Documents.

BID ITEM 5: Aeration Blowers and Blower/Electrical/Maintenance Building - Lump Sum

Bid Item 5 includes, but is not limited to, payment for all work associated with the aeration blowers and the blower/electrical/maintenance building including furnishing, installing, and testing of structural concrete, blowers, building, HVAC, bridge crane, maintenance room equipment, piping, valves, supports, electrical, instrumentation and control, and site work, including structural excavation, subgrade preparation and backfill, to provide a functional and operational system in accordance with the Contract Documents. Aeration Blowers and Blower/Electrical/Maintenance Building are typically shown on drawings starting with process area number "27", and also on drawings C-23 and C-28.

Bid Item 5 excludes all work included under Bid Item 15. It shall be the Contractor's sole responsibility to confirm the scope of Bid Item 15 against the scope of Bid Item 5 to avoid duplication of supply and services.

Payment for the aeration blowers and the blower blower/electrical/maintenance building will be made at the bid price in the Bid Schedule under Bid Item 5, which price shall constitute full compensation for completion of all such work as required per the Contract Documents.

BID ITEM 6: Secondary Clarifier No. 3 and RAS Pump Station/Building – Lump Sum

Bid Item 6 includes, but is not limited to, payment for all work associated with Secondary Clarifier No. 3 and RAS Pump Station North including furnishing, installing, and testing of structural concrete for clarifier tank and pump station building, sump pumps, supply and exhaust fans, grating, handrails, piping, valves, supports, electrical, instrumentation and control, and site work, including structural excavation, subgrade preparation and backfill, to provide a functional and operational system in accordance with the Contract Documents. Secondary Clarifier No. 3 and RAS Pump Station/Building are typically shown on drawings starting with process area number "34" and "36", and also on drawings C-23 and C-28.

Bid Item 6 excludes payment for RAS sump pumps and clarifier mechanism equipment, which are included in Bid Items 9 and 7, respectively. Bid Item 6 excludes all work included under Bid Item 15. It shall be the Contractor's sole responsibility to confirm the scope of Bid Item 15 against the scope of Bid Item 6 to avoid duplication of supply and services.

Payment for Secondary Clarifier No. 3 and RAS Pump Station North will be made at the bid price in the Bid Schedule under Bid Item 6, which price shall constitute full compensation for completion of all such work as required per the Contract Documents.

BID ITEM 7: Secondary Clarifier No. 3 (Sole Source Bid Item) – Lump Sum

Bid Item 7 includes payment for furnishing (1) one, 110-foot secondary clarifier mechanism supplied by Ovivo, appurtenances, and other items and manufacturer/vendor services as specified in Section 11231 and the Contract Documents, delivered freight of board to the Project site. Other costs for furnishing and testing the clarifier mechanism shall be included in Bid Item 7. The full scope for this Bid Item shall be as defined in the Quotation provided by the manufacturer/vendor, which is located in Appendix B to these Specifications.

Bid Item 3 excludes all work included under Bid Item 15. It shall be the Contractor's sole responsibility to confirm the scope of Bid Item 15 against the scope of Bid Item 7 to avoid duplication of supply and services.

All installation, materials, services and testing, equipment, appurtenances or other Work required to meet the requirements of Section 11231 or elsewhere in the Contract Documents but not included in the Quotation shall be the Contractors responsibility and shall be included and paid for under other Bid Item 6. Payment for the secondary clarifier mechanism and the full scope of the Quotation will be made at the bid price in the Bid Schedule under Bid Item 7, which price shall constitute full compensation for supply of this item.

BID ITEM 8: SCUM Pumps – (Sole Source Bid Item) Lump Sum

Bid Item 8 includes payment for furnishing (2) two, progressive cavity pumps for Scum service supplied by Netzsch, appurtenances, and other items and manufacturer/vendor services as specified in Section 11145 and the Contract Documents, delivered freight of board to the Project site. Other costs for furnishing and testing the pumps shall be included in Bid Item 8. The full scope for this Bid Item shall be

as defined in the Quotation provided by the manufacturer/vendor, which is located in Appendix B to these Specifications.

Bid Item 8 excludes all work included under Bid Item 15. It shall be the Contractor's sole responsibility to confirm the scope of Bid Item 15 against the scope of Bid Item 8 to avoid duplication of supply and services.

All installation, materials, services and testing, equipment, appurtenances or other Work required to meet the requirements of Section 11145 or elsewhere in the Contract Documents but not included in the Quotation shall be the Contractor's responsibility and shall be included and paid for under Bid Item 16. Payment for the Scum pumps and the full scope of the Quotation will be made at the bid price in the Bid Schedule under Bid Item 8, which price shall constitute full compensation for supply of this item.

BID ITEM 9: Filter Feed Pump and RAS Sump Pumps (Sole Source Bid Item) – Lump Sum

Bid Item 9 includes payment for furnishing (1) one, submersible non-clog pump for filter feed service and two submersible non-clog pump for RAS sump service supplied by Flygt, appurtenances, and other items and manufacturer/vendor services as specified in Section 11148 and the Contract Documents, delivered freight of board to the Project site. Other costs for furnishing and testing the pumps shall be included in Bid Item 9. The full scope for Bid Item 9 shall be as defined in the Quotation provided by the manufacturer/vendor, which is located in Appendix B to these Specifications.

Bid Item 9 excludes all work included under Bid Item 15. It shall be the Contractor's sole responsibility to confirm the scope of Bid Item 15 against the scope of Bid Item 9 to avoid duplication of supply and services.

All installation, materials, services and testing, equipment, appurtenances or other Work required to meet the requirements of Section 11148 or elsewhere in the Contract Documents but not included in the Quotation shall be the Contractor's sole responsibility and shall be included and paid for under other Bid Item 16. Payment for the Filter Feed pumps will be made at the bid price in the Bid Schedule under Bid Item 10, which price shall constitute full compensation for supply of this item.

BID ITEM 10: Chlorine Contact Tank Modifications – Lump Sum

Bid Item 10 includes, but is not limited to, payment for all work associated with modifying the chlorine contact tanks including demolition of existing facilities as defined int he Contract Documents and furnishing, installing, and testing of structural concrete, baffle walls, grating, piping, gates, valves, supports, electrical, instrumentation and control, and site work to provide a functional and operational system in accordance with the Contract Documents. Chlorine Contact Tank Modifications are typically shown on drawings starting with process area number "60".

Bid Item 10 excludes all work included under Bid Item 15. It shall be the Contractor's sole responsibility to confirm the scope of Bid Item 15 against the scope of Bid Item 10 to avoid duplication of supply and services.

Payment for modifying the chlorine contact tanks will be made at the bid price in the Bid Schedule under Bid Item 10, which price shall constitute full compensation for completion of all such work as required per the Contract Documents.

BID ITEM 11: WAS Storage - Lump Sum

Bid Item 11 includes, but is not limited to, payment for all work associated with WAS Storage including furnishing, installing, and testing of structural concrete, blowers, diffusers, handrails, piping, valves, supports, electrical, instrumentation and control, and site work, including structural excavation, subgrade preparation and backfill, to provide a functional and operational system in accordance with the Contract Documents. WAS Storage is typically shown on drawings starting with process area number "51", and also on drawings C-22 and C-27.

Bid Item 11 excludes all work included under Bid Item 15. It shall be the Contractor's sole responsibility to confirm the scope of Bid Item 15 against the scope of Bid Item 11 to avoid duplication of supply and services.

Payment for WAS Storage will be made at the bid price in the Bid Schedule under Bid Item 12, which price shall constitute full compensation for completion of all such work as required per the Contract Documents.

BID ITEM 12: 21kV Service Upgrade - Lump Sum

Bid Item 12 includes payment for all work to provide a 21kV service upgrade from PG&E based upon all labor, equipment, and materials necessary to complete the work in accordance with the requirements specified in the Contract Documents. Contractor shall provide all facilities required for the 21kV service upgrade, except for the PG&E interrupter and pulling of the 21kV wires and final termination, which will be performed by PG&E. Contractor shall include time required to coordinate with PG&E for engineering equipment review, inspections, and final termination. Coordination shall include submitting equipment technical details, ensuring equipment complies and with PG&E interconnection standards, establishing final protective settings per PG&E technical reviews, and ensuring the equipment provided under Bid Item 15 is in accordance with PG&E requirements and the Contract Documents.

Bid Item 12 excludes all work included under Bid Item 15. It shall be the Contractor's sole responsibility to confirm the scope of Bid Item 15 against the scope of Bid Item 12 to avoid duplication of supply and services.

Payment for 21kV upgrades will be made at the bid price in the Bid Schedule under Bid Item 12, which price shall constitute full compensation for completion of all such work as required per the Contract Documents.

BID ITEM 13: Ground Improvements (Stone Columns) – Lump Sum

Bid Item 14 includes payment for all stone columns required as shown on Drawing G-13 and Section 02255 including associated specifications. Payment under this item shall include the following:

a. Design and construction of the stone columns including layout work.
b. Furnishing crushed stone for the stone columns.
c. Furnishing equipment, electrical power, water, and any other necessary items for the stone column construction.
d. Control and disposal of water (surface and subsurface byproduct water) resulting from the stone column construction.
e. Construction of working pad necessary for the stone column construction.
f. Construction and removal of slit setting ponds (or similar) as required, and the regrading of site areas disturbed by the stone column construction.
g. Stockpiling and disposal of clay, silt, and organic materials washed up from stone column construction, if necessary.

h. Load testing of stone columns as specified.
i. Maintaining daily field records as specified.

Payment for the stone column ground improvement work will be made at the bid price in the Bid Schedule under Bid Item 13, which price shall constitute full compensation for completion of all such work as required per the Contract Documents.

BID ITEM 14: Ground Improvements (Jet Grouting) – Lump Sum

Bid Item 14 includes payment for all work required for jet grouting as specified in Section 02256. This item shall include the work to design and install jet grouting where required per the Contract Documents. Payment under this item shall include the following:

a. Furnishing equipment, electrical power, water, and any other necessary items for construction.
b. Install and remove grout pipes
c. Furnish and inject jet grout
d. Maintaining daily field records as specified.

Payment for the compaction grouting work will be made at the bid price in the Bid Schedule under Bid Item 14, which price shall constitute full compensation for completion of all such work as required per the Contract Documents.

BID ITEM 15: Process Control Systems, Process Control System Integration, Electrical Equipment and Instrumentation (Sole Source Bid Item) – Lump Sum

Bid Item 15 includes payment for furnishing process control systems, process control system integration and electrical equipment, instrumentation, appurtenances and other items and services as supplied by TESCO Controls, Inc and as specified in the Contract Documents. Bid Item 17 includes payment for services of Tesco Controls, Inc. as the Process Control System Integrator (PCSI) as specified in Section 13400 and the Contract Documents. This bid item includes some, but not all, work as specified in Sections 13400, 13420, 13421, 13422, 13430, 13430A, 13431, 13432, 13433, 13434, 13435, 13446, 13482, 13482A, 13490, 16000, 16145, 16265, 16271, 16290, 16350, 16360, 16436, 16440, 16441, 16442 and 16460.

The full scope for Bid Item 15 shall be as defined in the Quotation provided by the TESCO Controls, Inc, which is located in Appendix B to these Specifications. All installation, materials, services and testing, equipment, appurtenances or other work required to meet the requirements of the specification section indicated above or elsewhere in the Contract Documents but not included in the Quotation shall be the Contractor's sole responsibility and shall be included and paid for under the bid item for the respective system/equipment.

For purposes of defining the Base Bid, the Base Bid shall include Items 1 through 48 of the TESCO Controls, Inc, Quotation. The remaining items from this quotation are included in Additive Bid items, as defined below except Item 51 of the TESCO Controls, Inc Quotation that relates to the execution of work under Bid Items 3 and 4 at the discretion of the Bidder.

Payment for the process control systems will be made at the bid price in the Bid Schedule under Bid Item 19, which price shall constitute full compensation for supply of this item.

BID ITEM 16: All Other Work – Lump Sum

Bid Item 16 includes payment for all work required for the Base Bid scope under the Contract except for work specifically being provided under Bid items 1 through 15. Bid Item 16 includes all work required to meet the full requirements of the Contract Documents for Sole Source Bid Items but not included in the manufacturer/vendor quotations for these items, as defined in the bid item descriptions above. This item shall constitute full compensation for all such work as required per the Contract Documents. Payment for "all other work" will be made at the bid price in the Bid Schedule under Bid Item 16, which price shall constitute full compensation for completion of all such work as required per the Contract Documents.

ADDITIVE BID ITEMS

BID ITEM A1: Landscaping and Irrigation – Lump Sum

Bid Item A1 includes payment for all work required to provide landscaping and irrigation as required by the Contract Documents. This item shall include but is not limited to the installation of all irrigation piping, valves and valve boxes, sprinklers heads, and associated controllers, and the planting of all turf and trees as required in the Contract Documents. Table 01025-1 lists all drawings and specification sections that show work included in this bid item. For items listed in Column A in Table 01025-1, all work shown on those sheets or specification sections are included in this bid item. For items listed in Column B in Table 01025-1, a portion of that drawing or specification is included in this Bid Item. The portion of work included in this Bid Item is noted either on the respective drawing, specification section, or in this specification section.

Payment for the landscaping and irrigation work will be made at the bid price in the Bid Schedule under Bid Item A1, which price shall constitute full compensation for completion of all such work as required per the Contract Documents.

Table 01025-1: Work included in Bid Item A1

Drawing Number/ Specification Section	Drawing/Specification Title	Column A: Entire Item included in Bid Item	Column B: Portion of Item included in Bid Item
L-01	IRRIGATION NOTES AND LEGENDS	x	
L-02	OVERALL IRRIGATION PLAN, NOTES, AND LEGENDS		x
L-07	IRRIGATION PLAN		x
L-08	IRRIGATION PLAN	x	
L-09	IRRIGATION PLAN	x	
L-10	IRRIGATION DETAILS	x	
L-11	PLANTING NOTES AND LEGENDS	x	
L-12	OVERALL PLANTING PLAN	x	
L-13	PLANTING PLAN		x
L-14	PLANTING PLAN	x	
L-15	PLANTING PLAN	x	
L-16	PLANTING DETAILS	x	
Section 02810	Irrigation	x	
Section 02900	Planting	x	

BID ITEM A2: Biosolids Dryer and Building - Lump Sum

Bid Item A2 includes, but is not limited to, payment for all work associated with the biosolids dryer and building including furnishing, installing, and testing of structural concrete, paddle type dryer system, screw conveyors, building, HVAC, bridge crane, piping, valves, supports, electrical, instrumentation and control, and site work to provide a functional and operational system in accordance with the Contract Documents except landscaping and irrigation work which is included in Bid Item A1. All work associated with process area number "52" is included in this Bid Item. Table 01025-2 lists all drawings and specification sections that show work included in this bid item. For items listed in Column A in Table 01025-2, all work shown on those sheets or specification sections are included in this bid item. For items listed in Column B in Table 01025-2, a portion of that drawing or specification is included in this Bid Item. The portion of work included in this Bid Item is noted either on the respective drawing, specification section, or in this specification section.

Additionally, Bid Item A2 includes Items 49, 50, 53, 54, and 55 of the TESCO Controls, Inc. Quotation (Appendix B to these specifications). These are Sole Source Bid Items with a total cost of $195,000. All installation, materials, services and testing, equipment, appurtenances or other Work required to meet the requirements of the Contract Documents but not included in the Quotation shall be the Contractors responsibility and shall be included and paid for under other Bid Item A2.

Payment for the biosolids dryer and building will be made at the bid price in the Bid Schedule under Bid Item A2, which price shall constitute full compensation for completion of all such work as required per the Contract Documents.

Table 01025-2: Work included in Bid Item A2

Drawing Number/ Specification Section	Drawing/Specification Title	Column A: Entire Item included in Bid Item	Column B: Portion of Item included in Bid Item
G-6	SOLIDS HANDLING SCHEMATIC		x
G-7	DETAILED BIOSOLIDS DRYER SCHEMATIC 1 OF 2	x	
G-8	DETAILED BIOSOLIDS DRYER SCHEMATIC 2 OF 2	x	
G-9	DESIGN CRITERIA		x
G-13	GROUND IMPROVEMENT SITE PLAN		x (All work associated with Area 52 included in this Bid Item)
G-14	CONTRACTOR STAGING AREA AND TRAFFIC ACCESS PLAN		x
D-2	PLAN – 1	x	
D-3	PLAN – 2		x
14-D-01	BIOSOLIDS/DRYER BUILDING PLAN - FLOOR ELEVATION 71.96	x	
14-D-02	BIOSOLIDS/DRYER BUILDING - SECTION AND PHOTOS	x	
CP-2	CATHODIC PROTECTION SITE MAP 1		x
CP-3	CATHODIC PROTECTION SITE MAP 2		x
C-1	CIVIL LEGEND AND NOTES		x
C-20	SITE PLAN, KEY MAP AND SURVEY DATA	x	
C-21	GRADING AND PAVING - 1		x
C-26	YARD PIPING - 1		x

Drawing Number/ Specification Section	Drawing/Specification Title	Column A: Entire Item included in Bid Item	Column B: Portion of Item included in Bid Item
C-27	YARD PIPING - 2		x
C-29	YARD PIPING - 4		x
C-34	STORM DRAIN PROFILES		x
C-35	STORM DRAIN PROFILES		x
C-36	STORM DRAIN PROFILES		x
C-37	DRAIN PROFILES		x
C-38	SEWER PROFILES		x
L-03	IRRIGATION DEMO PLAN		x
A-1	BUILDING DATA, OCCUPANCY/EXITING DIAGRAMS		x (All work associated with Area 52 included in this Bid Item)
A-2	SCHEDULES – DOOR, WINDOW & FINISH		x (All work associated with Area 52 included in this Bid Item)
52-A-01	BIOSOLIDS DRYER BUILDING FIRST AND SECOND FLOOR PLANS	x	
52-A-02	BIOSOLIDS DRYER BUILDING ROOF PLAN	x	
52-A-03	BIOSOLIDS DRYER BUILDING ELEVATIONS	x	
52-A-04	BIOSOLIDS DRYER BUILDING ELEVATIONS	x	
52-A-05	BIOSOLIDS DRYER BUILDING SECTIONS	x	
52-S-01	BIOSOLIDS DRYER BUILDING - FOUNDATION PLAN	x	
52-S-02	BIOSOLIDS DRYER BUILDING - FLOOR PLAN	x	
52-S-03	BIOSOLIDS DRYER BUILDING - INTERMEDIATE PLAN	x	
52-S-04	BIOSOLIDS DRYER BUILDING - ROOF PLAN	x	
52-S-05	BIOSOLIDS DRYER BUILDING - SECTION	x	
52-S-06	BIOSOLIDS DRYER BUILDING - SECTION	x	

Drawing Number/ Specification Section	Drawing/Specification Title	Column A: Entire Item included in Bid Item	Column B: Portion of Item included in Bid Item
52-S-07	BIOSOLIDS DRYER BUILDING - DETAILS	x	
52-S-08	BIOSOLIDS DRYER BUILDING - DETAILS	x	
52-S-09	BIOSOLIDS DRYER BUILDING - ELECTRICAL AND THERMAL OIL ROOM PARTIAL PLANS	x	
52-S-10	BIOSOLIDS DRYER BUILDING - SECTIONS	x	
52-S-11	BIOSOLIDS DRYER BUILDING - SECTIONS	x	
52-S-12	BIOSOLIDS DRYER BUILDING - SECTIONS	x	
52-S-13	BIOSOLIDS DRYER BUILDING - THERMAL OIL PIPING SUPPORTS FRAMES	x	
52-S-14	BIOSOLIDS DRYER BUILDING - THERMAL OIL PIPING SUPPORT DETAILS	x	
M-1	MECHANICAL LEGEND AND SCHEDULES		x
52-M-01	BIOSOLIDS/DRYER BUILDING OVERALL FLOOR PLAN, ELEVATION 52.96 SHEET 1 OF 2	x	
52-M-02	BIOSOLIDS/DRYER BUILDING OVERALL FLOOR PLAN, ELEVATION 52.96 SHEET 2 OF 2	x	
52-M-03	BIOSOLIDS/DRYER BUILDING OVERALL FLOOR PLAN, ELEVATION 71.96 SHEET 1 OF 2	x	
52-M-04	BIOSOLIDS/DRYER BUILDING OVERALL FLOOR PLAN, ELEVATION 71.96 SHEET 2 OF 2	x	
52-M-05	BIOSOLIDS/DRYER BUILDING ENLARGED FLOOR PLAN ELEVATION 71.96, DRIED SOLIDS TRUCK LOADING AREA	x	
52-M-06	BIOSOLIDS/DRYER BUILDING ENLARGED FLOOR PLAN ELEVATION 52.96, DRYER AREA	x	
52-M-07	BIOSOLIDS/DRYER BUILDING ENLARGED FLOOR PLAN ELEVATION 71.96, BELT FILTER PRESS AREA	x	
52-M-08	BIOSOLIDS/DRYER BUILDING ENLARGED FLOOR PLAN, THERMAL OIL HEATER ROOM	x	
52-M-09	BIOSOLIDS/DRYER BUILDING SECTIONS SHEET 1 OF 7	x	
52-M-10	BIOSOLIDS/DRYER BUILDING SECTIONS SHEET 2 OF 7	x	
52-M-11	BIOSOLIDS/DRYER BUILDING SECTIONS SHEET 3 OF 7	x	
52-M-12	BIOSOLIDS/DRYER BUILDING SECTIONS SHEET 4 OF 7	x	

Drawing Number/ Specification Section	Drawing/Specification Title	Column A: Entire Item included in Bid Item	Column B: Portion of Item included in Bid Item
52-M-13	BIOSOLIDS/DRYER BUILDING SECTIONS SHEET 5 OF 7	x	
52-M-14	BIOSOLIDS/DRYER BUILDING SECTIONS SHEET 6 OF 7	x	
52-M-15	BIOSOLIDS/DRYER BUILDING SECTIONS SHEET 7 OF 7	x	
52-M-16	SOLIDS PROCESSING/DRYER BUILDING PIPING DETAILS	x	
52-M-17	BIOSOLIDS/DRYER BUILDING OVERALL FLOOR PLAN, ELEVATION 52.96 - DRAINAGE PLAN	x	
52-M-18	BIOSOLIDS/DRYER BUILDING THERMAL FLUID PIPING - PLAN AND SECTION	x	
52-H-01	DRYER BUILDING - EQUIPMENT SCHEDULES	x	
52-H-02	DRYER BUILDING - HVAC FLOOR PLAN, ELEVATION 50.0	x	
E-01	OVERALL SITE PLAN		x
E-03	SITE PLAN 2		x
E-6	SITE PLAN 5		x
E-07	SINGLE LINE DIAGRAM DISTRIBUTION OVERVIEW		x
E-12	PLANT SOUTHSIDE DISTRIBUTION SINGLE LINE DIAGRAM		x
E-13	SWITCHGEAR ELEVATIONS		x
E-20	SINGLE LINE DIAGRAM - DPB1 (PARTIAL)	x	
E-24	SINGLE LINE DIAGRAM - DPD1	x	
E-25	SINGLE LINE DIAGRAM - MCC D1	x	
E-29	SINGLE LINE DIAGRAM - UPS DISTRIBUTION		x
E-30	ELEVATION – DPB1	x	
E-34	ELEVATION – DPD1	x	
E-35	ELEVATION - MCC D1		x
E-40	GROUNDING SCHEMATIC - 1		x
E-41	GROUNDING SCHEMATIC - 2		x
E-59	CONTROL SCHEMATICS – MISCELLANEOUS		x
E-60	DUCT BANK SECTIONS - 1		x
E-61	DUCT BANK SECTIONS - 2		x
E-62	DUCT BANK SECTIONS SHEET 3		x

Drawing Number/ Specification Section	Drawing/Specification Title	Column A: Entire Item included in Bid Item	Column B: Portion of Item included in Bid Item
E-63	DUCT BANK SECTIONS - 4		x
E-64	HANDHOLE SCHEDULE		x
E-71	PANELBOARD SCHEDULES – 2		x
E-80	FIRE ALARM SYSTEM RISER DIAGRAM		x
14-E-01	EXISTING BIOSOLIDS BUILDING BELT FILTER PRESS AREA - ELECTRICAL PLAN	x	
14-E-01	EXISTING BIOSOLIDS BUILDING LOWER LEVEL - ELECTRICAL PLAN	x	
15-E-01	21KV ELECTRICAL FACILITY – ELECTRICAL PLAN		x
16-E-01	EXISTING SCREENING & GRIT HANDLING BUILDING – ELECTRICAL ROOM PLAN		x
52-E-01	BIOSOLIDS/DRYER BUILDING – POWER AND SIGNAL PLAN	x	
52-E-02	BIOSOLIDS/DRYER BUILDING – LIGHTING PLAN	x	
52-E-03	BIOSOLIDS/DRYER BUILDING – ELECTRICAL ROOM PLAN	x	
52-E-04	BIOSOLIDS/DRYER BUILDING – INTERCONNECTION DIAGRAM	x	
52-E-05	BIOSOLIDS/DRYER BUILDING – SPECIAL SYSTEMS	x	
80-E-01	EXISTING OPERATIONS BUILDING ELECTRICAL PLAN	x	
I-01	CONTROL SYSTEM ARCHITECTURE MODIFICATIONS - 1		x
I-03	FIBER OPTIC ROUTING DIAGRAM		x
I-20	P&ID MISCELLANEOUS SYSTEMS – 1		x
I-21	P&ID MISCELLANEOUS SYSTEMS – 2		x
14-I-01	P&ID DEWATERED SLUDGE CONVEYORS 1 AND 2	x	
14-I-02	P&ID DEWATERED SLUDGE CONVEYORS 3 AND 4	x	
52-I-01	P&ID DEWATERED CAKE FEED SYSTEM	x	
52-I-02	P&ID PADDLE DRYER AND DISCHARGE CONVEYOR	x	
52-I-03	P&ID DRIED PRODUCT HANDLING SYSTEM	x	
52-I-04	P&ID DRIED SOLIDS LOAD OUT SYSTEM	x	
52-I-05	P&ID DRYER OFF-GAS HANDLING SYSTEM	x	
52-I-06	P&ID THERMAL FLUID SYSTEM	x	

Drawing Number/ Specification Section	Drawing/Specification Title	Column A: Entire Item included in Bid Item	Column B: Portion of Item included in Bid Item
52-I-07	P&ID COMPRESSED AIR AND UTILITY WATER SYSTEM	x	
52-I-08	P&ID DUST CONTROL SCRUBBER	x	
52-I-09	P&ID PADDLE DRYER SPRAY WATER SYSTEM	x	
SECTION 10400	IDENTIFYING DEVICES		x
SECTION 11600	BIOSOLIDS DRYER SYSTEM	x	
SECTION 13400	COMMON WORK RESULTS PROCESS INSTRUMENTATION AND CONTROLS		x
SECTION 13420	CONTROL PANELS AND HARDWARE		x
SECTION 13421	PROGRAMMABLE LOGIC CONTROLLERS AND COMPUTER CONTROL SYSTEMS		x
SECTION 13430	APPENDIX A - FIELD INSTRUMENT LIST		x
SECTION 13482	PROCESS CONTROL DESCRIPTIONS		x
SECTION 14552	SCREW CONVEYOR - MODIFICATIONS AND IMPROVEMENTS	x	
SECTION 15200	VALVES, GENERAL		x
SECTION 15310	FIRE PROTECTION PIPING AND VALVES	x	
SECTION 15340	SPRINKLER SYSTEMS	x	
SECTION 16000	COMMON WORK RESULTS FOR ELECTRICAL		x
SECTION 16122	APPENDIX A - FIBER ALLOCATION TABLE		x
SECTION 16130	APPENDIX A - CONDUIT SCHEDULE		x
SECTION 16500	APPENDIX A - LIGHT FIXTURES SCHEDULE		x

Drawing Number/ Specification Section	Drawing/Specification Title	Column A: Entire Item included in Bid Item	Column B: Portion of Item included in Bid Item
SECTION 16910	FIRE DETECTION AND ALARM SYSTEM	x	

BID ITEM A3: Dried Solids Storage Building - Lump Sum

Bid Item A3 includes, but is not limited to, payment for all work associated with the dried solids storage building including furnishing, installing, and testing of structural concrete, building, piping, valves, supports, electrical, instrumentation and control, and site work to provide a functional and operational system in accordance with the Contract Documents. All work associated with process area number "53" is included in this Bid Item. Table 01025-3 lists all drawings that show work included in this bid item. For drawings listed in Column A in Table 01025-3, all work shown on those sheets are included in this bid item. For drawings listed in Column B in Table 01025-3, a portion of that drawing as noted either on the drawing or in this specification section is included in this bid item. On drawings A-1 and A-2, all work associated with Process Area 53 is included in this Bid Item.

Payment for the dried solids storage building will be made at the bid price in the Bid Schedule under Bid Item A3, which price shall constitute full compensation for completion of all such work as required per the Contract Documents.

Table 01025-3: Work included in Bid Item A3

Drawing Number/ Specification Section	Drawing Title	Column A: Entire Item included in Bid Item	Column B: Portion of Item included in Bid Item
G-13	GROUND IMPROVEMENT SITE PLAN		x
G-14	CONTRACTOR STAGING AREA AND TRAFFIC ACCESS PLAN		x
D-6	PLAN - 5		x
C-1	CIVIL LEGEND AND NOTES		x
C-24	GRADING AND PAVING - 4		x
C-29	YARD PIPING - 4		x
L-06	IRRIGATION DEMO PLAN	x	

Drawing Number/ Specification Section	Drawing Title	Column A: Entire Item included in Bid Item	Column B: Portion of Item included in Bid Item
A-1	BUILDING DATA, OCCUPANCY/EXITING DIAGRAMS		x (All work associated with Area 53 included in this Bid Item)
A-2	SCHEDULES – DOOR, WINDOW & FINISH		x (All work associated with Area 53 included in this Bid Item)
53-A-01	BIOSOLIDS STORAGE FLOOR PLAN	x	
53-A-02	BIOSOLIDS STORAGE ROOF PLAN	x	
53-A-03	BIOSOLIDS STORAGE ELEVATIONS	x	
53-A-04	BIOSOLIDS STORAGE ELEVATIONS	x	
53-S-01	BIOSOLIDS STORAGE BUILDING - FOUNDATION PLAN	x	
53-S-02	BIOSOLIDS STORAGE BUILDING - INTERMEDIATE PLAN	x	
53-S-03	BIOSOLIDS STORAGE BUILDING - ROOF PLAN	x	
53-S-04	BIOSOLIDS STORAGE BUILDING - SECTIONS	x	
53-S-05	BIOSOLIDS STORAGE BUILDING - SECTION	x	
53-S-06	BIOSOLIDS STORAGE BUILDING - SECTIONS AND DETAILS	x	
E-01	OVERALL SITE PLAN		x
E-06	SITE PLAN 5		x
E-62	DUCT BANK SECTIONS – SHEET 3		x
E-64	HANDHOLE SCHEDULE		x
E-73	PANELBOARD SCHEDULES – 4		x
E-80	FIRE ALARM SYSTEM RISER DIAGRAM		x
15-E-01	21KV ELECTRICAL FACILITY – ELECTRICAL PLAN		x
40-E-01	EXISTING CHEMICAL BUILDING – POWER AND SIGNAL PLAN		x
53-E-01	BIOSOLIDS STORAGE BUILDING – LIGHTING AND SPECIAL SYSTEMS PLAN	x	

Drawing Number/ Specification Section	Drawing Title	Column A: Entire Item included in Bid Item	Column B: Portion of Item included in Bid Item
SECTION 16500	APPENDIX A - LIGHT FIXTURES SCHEDULE		x
SECTION 16910	FIRE DETECTION AND ALARM SYSTEM	x	

PART 3 CONTRACTOR'S SCHEDULE OF VALUES (APPLICABLE FOR LUMP SUM WORK)

For work to be performed for a lump sum amount, the Contractor shall submit a schedule of values per General Conditions Article 8.1 to the Construction Manager prior to the first payment and within ten (10) days after Notice to Proceed. The schedule of values, as agreed upon by the Contractor and the Construction Manager, shall be used for preparing future estimates for partial payments to the Contractor, and shall list the major items of work with a price fairly apportioned to each item. Mobilization, overhead, bond, insurance, other general costs and profit shall be prorated to each item so that the total of the prices for all items equal the lump sum price. At the discretion of the Construction Manager, mobilization, bond and insurance costs may be provided for separately if accompanied by invoices to verify actual expenses.

The schedule of values shall be generally in the same format as the Contract specifications divisions and subdivisions, with major items of work listed individually. The schedule of values shall be by structure, civil, landscaping, or other logical division of work. The schedule of values for architectural, structural, mechanical, and electrical work shall include separate items for identifiable portions of the structures. The schedule of values shall include separate allowances for any testing and startup work required. Measurable approximate quantities of work performed by the Contractor or its subcontractors shall be provided. For quantities that are the sum total of several individual quantities, backup summaries shall be provided which list the individual descriptions and quantities. These summaries then will be used to determine the quantities of work in place in subsequent progress payment requests.

The above is a statement of the intent of the Contract Documents to provide a moderate level of detail, acceptable to the Construction Manager, to allow a fair and reasonable estimate to be made of the value of work installed. The detail of the schedule of values must be sufficient to provide timely processing of the monthly progress payment request.

The schedule of values will be subject to the approval of the Construction Manager, and upon request, the Contractor shall substantiate the price for any or all items and provide additional level of detail, including quantities of work. The schedule of values shall be sufficiently detailed to permit its use by the Construction Manager as one of the bases for evaluating requests for payments. The Construction Manager shall be the sole judge of the adequacy of the schedule of values.

The schedule of values shall be solely used to determine progress payments. The schedule of values shall not be considered in determining payment or credit for additional or deleted work.

END OF SECTION

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SECTION 01050 - FIELD ENGINEERING

PART 1 DATUM

Vertical and horizontal datum is based on the coordinates and benchmarks shown on the Drawings. The Contractor shall establish other control and reference points from these Owner furnished reference points as required to properly layout the Work. All connections shall be installed based on actual elevations of existing structures to which connections are made.

Contractor shall protect control points and preserve permanent reference points during construction. Any control points or monuments lost, disturbed or destroyed by the Work shall be replaced by the Contractor's surveyor.

PART 2 QUALITY ASSURANCE

The Contractor's surveyor or engineer responsible for surveying specified herein shall be a registered land surveyor in the state of California.

PART 3 LINES AND GRADES

The Contractor shall lay out all work, including structures and pipelines, and shall be responsible for any errors resulting therefrom. In all questions arising as to proper location of lines and grades, the Construction Manager's decision will be final.

As part of the bid price for the construction of improvements, the Contractor shall provide and be responsible for the layout of all work. The Contractor shall provide all necessary surveys, field staking, and positioning for the construction of all components at the proper alignment, elevations, grades, and positions, as indicated on the Drawings and as required for the proper operation and function. The Contractor shall stake its work limits. The Contractor's surveyor shall check the line and grade of the slab forms prior to the first slab pour at each structure.

The Contractor's layout shall be based on existing structures, survey control and bench marks established by the Owner.

The Contractor shall supply such labor as required, at no extra charge, to aid and assist the Construction Manager in checking location and grades of work as set by the Contractor if the Construction Manager desires to perform this checking. This shall include moving materials and equipment located between monuments and the construction work.

END OF SECTION

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SECTION 01060 - REGULATORY REQUIREMENTS AND PERMITS

PART 1 APPLICABLE CODES

See Technical Specifications for Applicable Codes

PART 2 FEES AND PERMITS

2.1 CONTRACTOR FEES AND PERMITS

Contractor shall apply for, obtain, and comply with all the terms, conditions and requirements attached to all permits, bonds and licenses required by any local, state, or federal agencies to perform work, construct, erect, test and start up of any equipment or facility for this Contract. Where operating permits are required, the Contractor shall apply for and obtain such operating permits in the name of the Owner and provide the permit in an appropriate frame or fileholder when the Owner accepts the equipment or facility for beneficial use. The Contractor shall give all notices necessary and incidental to the due and lawful prosecution of the Work.

Any permits, bonds, licenses and fees therefore required for the performance of work under this Contract and not specifically mentioned herein as being reimbursed by the Owner shall be included in the Contractor's Bid price (see Section 2.2). The Contractor shall apply for and obtain all safety permits for excavations, tunneling, trenches, construction (building structure, scaffolding, or falsework) and demolition required by CAL/OSHA.

2.2 LOCAL AGENCY AND BUILDING CODE FEES AND PERMITS

The Owner shall obtain and pay for all local agency permits except for Fire Department permits. The Contractor shall apply for and obtain in its name any permits not obtained by the Owner and the Contractor shall be responsible for satisfying all code requirements, calling for inspections, and obtaining final approvals. The Contractor shall notify the Construction Manager of the need and the readiness of all required inspections. All inspections are to be coordinated with the Construction Manager. The Contractor shall comply with all construction conditions stipulated in the permits. All other permits and inspection fees including Fire Department permits and any outside agency permits will be the sole responsibility of the Contractor and shall be included in the Bid Price. The Contractor shall be responsible for and the Owner shall not provide reimbursement for any costs required for the reinspection of defective work or additional costs due to the Contractor’s failure to properly schedule the inspections. The Contractor shall comply with the provisions of any and all permits obtained by the Owner and contained in the appendix to these Specifications.

2.3 PERMITS TO BE OBTAINED BY CONTRACTOR

The Contractor shall be responsible for obtaining, and complying with all the terms, conditions and requirements of any permits required for completion of the work not obtained by the Owner. The Contractor will pay for all permit and inspection fees not paid for by the Owner . The Contractor shall provide any required deposits and will not be reimbursed for deposits that are forfeited for non-compliance. Copies of all permits obtained by the Contractor shall be provided to the Owner and the Construction Manager.

END OF SECTION

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SECTION 01090 - REFERENCES

PART 1 GENERAL

1.1 CODES AND STANDARDS

A. Whenever reference is made to a code or standard, it means the latest edition in effect the date that the Contract Documents are dated. Where codes, standards and reference documents are referred to in the Contract Documents, the Contractor may submit a written request to the Construction Manager for assistance in locating such documents. Within three days of receipt of such request, the Construction Manager or the Design Consultant will notify the Contractor as to where the document(s) can be reviewed.

1.2 DEFINITIONS OF WORDS AND TERMS

A. Refer to Article 1 of the General Conditions for project definitions.

1.3 REFERENCE DOCUMENTS

A. Record Drawings for the Brentwood Wastewater Treatment Plant Expansion Project, Brentwood, California. July 2005.

B. Geotechnical Investigation Report, Brentwood Wastewater Treatment Plant Expansion Project, Brentwood, California", dated September 12, 2017, prepared by Cal Engineering & Geology, Inc. An addendum to the Geotechnical Investigation Report was issued on February 27, 2018.

C. Geotechnical Engineering Investigation Report, City of Brentwood, Brentwood Wastewater Treatment Plant Expansion Project, Brentwood, California", dated January 2000, prepared by DCM/Joyal Engineering.

D. Geotechnical information collected during the construction of the existing ground improvement during the Phase I treatment plant construction is available in electronic (PDF) format.

1.4 ABBREVIATIONS

A. Whenever the following terms are used, the intent and meaning shall be as follows:

B. Abbreviation Stands For

AASHTO	American Association of State and Highway and Transportation Officials
AAMA	Architectural Aluminum Manufacturers Association
ABMA	American Boiler Manufacturers Association
ACI	American Concrete Institute
ADC	Air Diffusion Council
AGA	American Gas Association
AGMA	American Gear Manufacturers Association

AISC	American Institute of Steel Construction
AISI	American Iron and Steel Institute
AMCA	Air Moving and Conditioning Association
ANSI	American National Standard Institute (formerly United States of America Standards Institute)
APA	American Plywood Association
API	American Petroleum Institute
AREA	American Railway Engineers Association
ASCE	American Society of Civil Engineers
ASHRAE	American Society of Heating, Refrigerating and Air Conditioning Construction Managers
ASME	American Society of Mechanical Engineers
ASTM	American Society of Testing and Materials
AWPA	American Wood-Preserver's Association
AWS	American Welding Society
AWWA	American Water Works Association
CAGI	Compressed Air and Gas Institute CAL/OSHA State of California Department of Industrial Relations, Division of Industrial Safety
CBC	California Building Code
CBM	Certified Ballast Manufacturers
CBR	California Bearing Ratio
CI	Chlorine Institute
CISPI	Cast Iron Soil Pipe Institute
CMAA	Crane Manufacturers Association of America
CPSC	Consumer Products Safety Commission
CRA	California Redwood Association
CRSI	Concrete Reinforcing Steel Institute
CTI	Cooling Tower Institute
DFPA	Douglas Fir Plywood Association
EIA	Electronic Industries Association
EPA	U.S. Environmental Protection Agency
ETL	Electronic Testing Laboratory
FM	Factory Mutual Insurance Company
FPS	Fluid Power Society
FS	Federal Specifications
GO 95	General Order No. 95, California Public Utilities Commission Rules for Overhead Electric Line Construction
HI	Hydraulic Institute
HMI	Hoist Manufacturers Institute
IAPMO	International Association of Plumbing and Mechanical Officials
IBR	Institute of Boiler and Radiator Manufacturers
ICBO	International Conference of Building Officials
IEEE	Institute of Electrical and Electronic Engineers
IES	Illuminating Engineering Society
IPCE	International Power Cable Engineers Association
ISA	Instrument Society of America
MIL	Military Specifications
MSS	Manufacturer’s Standardization Society
NAAMM	National Association of Architectural Metal Manufacturers
NBS	National Bureau of Standards
NEC	National Electric Code
NEMA	National Electrical Manufacturers Association
NFPA	National Fire Protection Association

NSF	National Sanitation Foundation
NWMA	National Woodwork Manufacturers Association
OSHA	Occupational Safety and Health Administration
PCMAC	Prestressed Concrete Manufacturers Association of California
SMACNA	Sheet Metal and Air Conditioning Contractors National Association
SSPC	Structural Steel Painting Council TCA Tile Council of America
UBC	Uniform Building Code
UFC	Uniform Fire Code
UPC	Uniform Plumbing Code
UL	Underwriters Laboratories
WCLIB	West Coast Lumber Inspection Bureau
WIC	Woodwork Institute of California

PART 2 NOT USED

PART 3 NOT USED

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SECTION 01200 - PROJECT MEETINGS

PART 1 PRE-CONSTRUCTION CONFERENCE

Prior to the start of construction the Construction Manager will conduct a pre-construction conference that shall be attended by the Contractor's Project Manager/Project Engineers and major subcontractors and major equipment and material suppliers, effected utilities and others as determined by the Contractor and Construction Manager. At the conference the following shall be reviewed - the Contractor's proposed schedule of operations and the construction procedure and sequence requirements, Contractor's field organization, submittals, progress payment procedures, change order procedures, Contractor Safety Program, safety requirements, permits and inspections, and other matters.

PART 2 PROGRESS MEETINGS

The Construction Manager shall schedule, arrange and conduct progress meetings. These meetings shall be conducted not more than once per week and shall be attended by the Contractor's superintendent and representatives of all subcontractors, utilities, and others, who are active in the execution of the Work. The purpose of these meetings shall be to review the Contractor's three week schedule provided in accordance with article 5.2 of the General Conditions, resolve conflicts, and in general, coordinate and expedite the execution of the Work.

The agenda of progress meetings shall include, as a minimum, review of progress and schedule of the Work and any other matters related to the execution of the Work. The Construction Manager shall prepare and distribute record of discussions of the meetings.

PART 3 OTHER PROJECT MEETINGS

The Contractor shall attend and require the participation of other subcontractors or suppliers for other project related meetings when requested by the Construction Manager or Owner.

END OF SECTION

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SECTION 01210 - PROJECT DOCUMENT CONTROL SYSTEM

PART 1 WEB DATABASE

The City will use and maintain a web-based database as the primary means of communication related to the Project's correspondence, submittals, requests for information (RFIs), advisory notices, and non-compliance issues. Correspondence from the Contractor shall be sent to the Construction Administrator via the City's web-based database system. The system that will be used on this project is PROCORE.

The Construction Administrator and Contractor shall utilize the named system for electronic submittal of all data and documents (unless specified otherwise by the Construction Administrator) throughout the duration of the Contract. The web-based database will be made available to the Contractor's project personnel. The joint use of this system is to facilitate electronic exchange of information, automation of key processes, and overall management of the Contract. It shall be the primary means of project information submission and management. When required by the Construction Administrator, paper documents will also be required.

1.1 USER ACCESS LIMITATIONS

The Construction Administrator will control the Contractor's access to the web-based system by allowing access and assigning user profiles to accepted Contractor personnel. User profiles will define levels of access into the system, determine assigned function-based authorizations (determines what can be seen) and user privileges (determines what they can do).

1.2 AUTOMATED SYSTEM NOTIFICATION AND AUDIT LOG TRACKING

Review comments made (or lack thereof) by the Construction Administrator and Designer on Contractor submitted documentation shall not relieve the Contractor from compliance with requirements of the Contract Documents. The Contractor is responsible for managing, tracking, and documenting the Work to comply with the requirements of the Contract Documents. Neither automated system notifications nor audit logs constitute validation of the Contractor's submitted information.

1.3 CONTRACTOR RESPONSIBILITY

The Contractor shall be responsible for the validity of their information submitted in the online system and for the abilities of their personnel. Accepted users shall be knowledgeable in the use of computers, including Internet Browsers, email programs, and Adobe Portable Document Format (PDF) document distribution program. Adobe PDF documents shall be created through electronic conversion rather than optically scanned whenever possible. The Contractor is responsible for the training of their personnel in the use of the web-based system (outside what is provided by the Construction Administrator) and the other programs indicated above as needed.

1.4 CONNECTIVITY PROBLEMS

The database system is a web-based environment and therefore subject to the inherent speed and connectivity problems of the Internet. The Contractor is responsible for its own connectivity to the Internet. The system's response time is dependent on the Contractor's equipment, including processor speed, Internet access speed, etc. and current traffic on the Internet. The City and Construction Administrator will not be liable for any delays associated from the usage of

the online database including, but not limited to: slow response time, down time periods, connectivity problems, or loss of information. The Contractor will ensure that connectivity to the web-based system is accomplished through some form of high-speed communications with 5 Mbps as the minimum bandwidth requirements for using the system. It is recommended a faster connection be used when uploading pictures and files into the system. Under no circumstances shall the usage of the web-based database be grounds for a time extension or cost adjustment to the Contract. If there are problems that persist with the online system site for more than 24 consecutive hours that prevent the electronic submission of data by the Contractor, the Contractor may submit documents to the Construction Administrator until such time that the Construction Administrator notifies the Contractor that the website is operable and available for use.

1.5 TRAINING

The City has arranged for the following training to be provided to the Contractor. The Construction Administrator will provide a one hour training class to the Contractor within ten (10) days of NTP at a time mutually agreeable to Contractor and Construction Administrator. Thereafter the Construction Administrator will provide up to one hour of additional training via telephone during the project per month of the project life.

PART 2 EQUIPMENT REQUIREMENTS

In order to process correspondence, submittals, and RFIs, the Contractor must provide and have in place for its own use the required basic components outlined below:

2.1 HARDWARE

A computer with internet access and sufficient capabilities to perform all duties stated in this Section; a scanner at least large enough to scan 11” x 17” sheets with sufficient resolution to maintain clarity and legibility of the document at its native size; and a color printer of sufficient size and capacity to accept incoming correspondence as described in this section.

2.2 SOFTWARE

Adobe Acrobat 11 Standard; a commonly utilized web browser (i.e. Internet Explorer, Firefox, or Chrome); Microsoft Office 2013 or higher, including but not limited to Microsoft Word and Microsoft Excel. Contractor is responsible for confirming current requirements for the specified web-based system.

2.3 FACILITIES

The Contractor shall make its own arrangements to provide high-speed (minimum speed: download 5 Mbps/upload 5 Mbps) internet connection for its own use as soon as practicable.

PART 3 EXECUTION

Items to be uploaded to the web-based database by the Construction Administrator include but are not limited to: RFI responses, Submittal comments, Clarification letters, Design Clarifications, Field Orders, Potential Change Orders, and System Outage Requests et al. These items will be attached in PDF file format. These attachments may include files that need to be viewed and/or printed in color. Formal letters, stop notices, Field Orders, Progress Payment Requests, and Contract Change Orders shall always include a wet-signed hard copy.

3.1 WEB-BASED DATABASE UTILIZATION

All project related correspondence (RFIs, submittals, etc.) originated by the Contractor or Subcontractor, Supplier, et al. shall be directed to the Construction Administrator, unless otherwise indicated in the Specifications.

A. Submittals

The use of the electronic communication does not waive the requirement for the provision of hard copies of all formal correspondence and submittals. The hard copies of all documents must match the electronic copies of all correspondence and submittals.

Submittals shall be in accordance with Section 01340. The provisions of Section 01340 shall apply both to electronic copies and hard copies of submittals, unless otherwise stated in writing by the Construction Administrator.

In addition to above, the web-based database shall be utilized in connection with submittal preparation and information management required but not limited to the following Sections of the Technical Specifications and the General Conditions:

1. 01010 Summary of Work
2. 01025 Measurement and Payment
3. 01340 Shop Drawings, Product Data and Samples
4. 01310 Progress Schedules and Reports

The web-based database will be utilized by all other Sections not listed above and as required and at the discretion of the Construction Administrator.

3.2 TERMINATION OF USE

The City reserves the right to terminate the use of the specified web-based database system, PROCORE, for the electronic submission of data to the City. The City may provide an alternate project control system or require the use of paper documents submitted in accordance with the Contract Documents. The Contractor will be provided in writing ten (10) days' notice that The City intends to discontinue use of PROCORE. Contractor access to the online document management system may not be available to the Contractor following completion of the Contract. The Contractor is responsible for maintaining their own records outside of the online management system.

3.3 ADOBE PDF

All information, comments, questions and statements shall be scanned and/or converted to the PDF file format and attached to the web-based database system. Items to be sent via the system include but are not limited to large-format plan sheets (22" x 34" or larger), small-format plan sheets, pages within tabbed binders, RFIs, transmittal sheets, et al. The PDF attachments supplied to the Construction Administrator shall be in a sufficient resolution to be fully legible at its native size.

All separate files within a given piece of correspondence shall be combined into a single PDF document (i.e. An RFI that contains a text file and two photo files shall be combined into a single PDF document prior to delivery to the Construction Administrator.)

3.4 PDF LABELING FORMAT

The subject line of each email, and the file name of any attached files shall begin with the file labeling scheme:

RFI_XXXY_(Subject)
Letter_XXXY_(Subject)
Transmittal_XXXY_(Subject)
PCO_XXXY_(Subject)
Submittal_XXX.ZZY_(Subject)

The first section of the label indicates the type of correspondence (i.e. RFI). “XXX” indicates a unique number, sequentially assigned for the given piece of correspondence. “Y” is a sequential letter assigned for revised or resubmitted documents, i.e. A, B, or C being the 1st, 2nd, and 3rd revision or resubmittal, respectively. The Contractor will indicate the subject at the end of the numbering scheme. For submittals, “ZZ” indicates a unique number, sequentially assigned for each package item. Each piece of correspondence shall be sent in a separate email.

If a submittal package has multiple items, each item shall be considered a separate piece of correspondence and sent separately. For example, if “Submittal 3: Concrete” had two items, “3.01: Mix Design,” and “3.02: Curing Compound,” two separate items would be emailed to the Construction Administrator labeled as:

Submittal_003.01_Mix Design
Submittal_003.02_Curing Compound

3.5 ORIGINAL DOCUMENTS

Where possible, the Contractor will obtain the electronic document from its original source to maintain the integrity, legibility, and searchability of the document.

3.6 ORGANIZATION

The information included in the attachments shall be organized in a logical and thoughtful manner. Where the information originated in a tabbed format (a binder, for example), the scanned and/or converted PDF file shall be electronically bookmarked accordingly using the “bookmark” function of Adobe Acrobat 9 Standard.

3.7 PRINTING

Except where otherwise indicated, the Contractor will receive no hard copies of the above outlined correspondence. The Contractor will be required to print for its use, in color if necessary, any record copies, field copies, sub-contractor copies, etc., if such copies are desired.

3.8 PROJECT FORMS

The Contractor shall use its own correspondence forms for attachments uploaded to the web-based database system. These forms shall include the identifying information specific to the

PDF document succeeding the cover form. Additionally, the Contractor shall input all identifying information within the web-based database as requested when generating a new document within the system.

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SECTION 01310 - PROGRESS SCHEDULES

PART 1 GENERAL

The Progress Schedule for this Project will also be referred to as the Critical Path Method (CPM) Schedule. Contractor shall comply with all schedule requirements listed in section 5.2 of the General Conditions.

The Contractor shall designate, in writing, an authorized representative in its firm who will be responsible for the preparation, revising, and updating of the CPM Schedule. The Contractor's representative shall have direct project control and complete authority to act on behalf of the Contractor in fulfilling the construction scheduling requirements set forth herein, and such authority will not be interrupted throughout the duration of the Project. The requirements for the CPM Schedule are included to assure adequate planning and execution of the work and to assist the Construction Manager in appraising the reasonableness of the proposed schedule and evaluating progress of the work.

The Contractor shall provide a properly formatted electronic file for the Preliminary Progress Schedule, Base Schedule and all monthly updates with the logic network diagram and mathematical analyses.

PART 2 NOT USED

PART 3 CONSTRUCTION SCHEDULE

3.1 DEMONSTRATION OF COMPETENCE

Within seven (7) days from award of the Contract, the Contractor shall submit to the Construction Manager demonstration of competence in the use of CPM Scheduling, including evidence of the use of CPM Scheduling projects similar in value and complexity. In the event of the failure of the Contractor to satisfy the Construction Manager of its CPM Scheduling competence, the Contractor will be required to employ a qualified CPM consultant who regularly performs these services and who in the opinion of the Construction Manager possesses the qualifications required to perform CPM Scheduling for this Project.

Demonstration of competence in the use of CPM Scheduling shall be indicated by providing evidence to verify capability of using the critical path method of construction scheduling by submitting: (1) The Contractor's or its CPM Consultant's experience in the application of CPM Scheduling techniques for at least two construction projects of similar size and complexity which were successfully controlled by the Contractor or its CPM consultant throughout their duration by means of CPM Scheduling and periodic systematic reviews of the CPM Schedules; (3) The Contractor's or its CPM consultant's experience with computer programs for production of CPM Schedules; and (4) Information regarding the Contractor's or its CPM consultant's computer facilities (either by possession or contractual access).

3.2 PRELIMINARY PROGRESS SCHEDULE

A. Within five (5) days after receipt of Notice to Proceed or Preconstruction Conference, whichever occurs first, the Contractor shall submit two (2) copies each of a Preliminary Progress Schedule in the form of time scaled logic diagram and a bar chart covering the following project phases and activities:

1. Procurement and Submittals, including shop drawings and fabrication and delivery of key and long lead time procurement items.

    a. The Contractor's submittal information shall show intended submittal dates and shall include, as a minimum, the maximum allowable review period as specified as a separate predecessor activity.
    b. The information shall provide sufficient durations for administration, fabrication and transportation to produce realistic delivery dates for the procurement items.

2. All activities planned for the first 90 days in the execution of the Work.

3. The approach to scheduling the remaining activities or phases of the Work shall be represented by at least one summary activity for each major phase or activity. The total duration of the summary activities shall equal the Contract Time.

4. Approximate duration for each summary activity representing the Contractor's best estimate for the work the summary activity represents.

B. The Preliminary Progress Schedule shall describe the activities to be accomplished and their dependency subject to all requirements under these Construction Schedule provisions, as appropriate. The Preliminary Progress Schedule will be used temporarily to record and monitor the progress of the Work until the Base Schedule, specified hereinafter, has been completely developed and favorably reviewed. Recorded data on the Preliminary Progress Schedule shall be incorporated into the Base Schedule during the first schedule update.

C. The Construction Manager shall review the Preliminary Progress Schedule and provide any comments, its favorable review of the Preliminary Progress Schedule, or request a meeting to review the Preliminary Progress Schedule with the Contractor within ten (10) days of receipt of the schedule. If requested, the Contractor shall participate in a review and evaluation of the schedule with the Construction Manager. Any revisions necessary as a result of this review shall be resubmitted for review by the Construction Manager within five (5) days.

3.3 BASE CPM SCHEDULE

A. Base CPM Schedule Submittal

1. The Contractor shall submit an acceptable Critical Path Method (CPM) Schedule to the Construction Manager within thirty (30) days after the receipt of the Notice to Proceed. Subsequent revisions to said Schedule shall be submitted as set forth hereinafter.

2. The Contractor shall produce and provide one (1) complete set each of time-scaled network logic diagrams and bar charts on 22-inch by 34-inch sheets. The network logic diagram shall be clear and legible. Critical activities shall be indicated in red color on both schedules.

3. The Construction Manager shall review the schedule and provide any comments, its favorable review of the schedule, or request a meeting to review the schedule with the Contractor within twenty (20) days of receipt of the schedule. If requested, the Contractor shall participate in a review and evaluation of the proposed network diagrams and analysis by the Construction Manager. Any revisions necessary as a result of this review shall be resubmitted for review by the Construction Manager

within twenty (20) days. When completed, the favorably reviewed schedule shall then be the schedule to be used by the Contractor for planning, organizing, and directing the work, and for reporting progress. If the Contractor thereafter desires to make significant changes in its method of operating and scheduling, the Contractor shall notify the Construction Manager in writing stating the reasons for the change.

4. No more than two progress payments will be made prior to submission and favorable review of the CPM Schedule by the Construction Manager.

5. To the extent that the favorably reviewed initial Construction Schedule, or revisions thereto, indicate anything not jointly agreed upon, it shall be deemed to be not favorably reviewed by the Construction Manager. Any omission of work from the detailed Base Schedule, otherwise required for Contract compliance, will not excuse the Contractor from completing such work within any applicable completion date.

B. Schedule Type

1. The CPM Schedule submitted under this Specification shall indicate completion of the project at the Contract completion date and shall incorporate the entire project duration. In accordance with the General Conditions, the Contractor is required to base their bid and the construction schedule on the entire Contract Time and include its field and home office overhead costs in the bid for the entire Contract Time

2. The critical path is defined as the longest continuous path of activities in a network logic diagram with the least amount of float.

3. The schedule shall be computer generated utilizing the **"Primavera"** scheduling program. The Contractor shall provide the Construction Manager with a licensed copy of the scheduling program. The copy shall be of the version used to prepare the project schedule. The program shall be capable of accepting revised completion dates as modified by approved time adjustments and recomputations of all tabulation dates and float accordingly.

4. The CPM Schedule shall not incorporate resource loading and leveling. The Contractor shall provide hard coded logic constraints as necessary to incorporate any resource requirements that may be applicable to the Project construction. The Contractor shall determine and allocate the proper resources to complete the Project by the specified Contract completion date.

C. Network Logic Diagram

1. The graphic network diagram shall include for each activity, the description, activity number, the estimated duration in workdays, and all activity relationship lines. The network diagram shall be drawn for the early start and early finish of all activities.

2. The diagrams shall show elements of the project in detail and an entire project summary. Diagrams shall show the order and interdependence of all activities and sequence in which the work is to be accomplished as planned by the Contractor and its subcontractors. The basic concept of a network analysis diagram shall be followed to show how the start of a given activity is dependent on the completion of preceding activities and its completion restricts the start of following activities. Network logic diagrams shall be time-scaled.

D. Reports

1. Two (2) copies of the following reports shall be provided.

   a. Tabular Reports

      1) Activity Report: Sort report by Activity ID
      2) Total Float Report: Sort report by Total Float, Early Start, Activity ID

   b. 11”x17” Color Time-Scaled Diagram: Breakdown by Work Area

2. The following information shall be furnished as a minimum for each activity;

   a. activity description and number
   b. estimated duration of activities
   c. earliest start date (by calendar date)
   d. earliest finish date (by calendar date)
   e. actual start date (by calendar date)
   f. actual finish date (by calendar date)
   g. latest start date (by calendar date)
   h. latest finish date (by calendar date)
   i. float
   j. percentage of activity completed.

3. In addition provide two (2) copies of the following report:

   a. Tabular Report – Predecessor/Successor Report: The report shall include the same information listed above plus the additional information listed below. This report shall be sorted by Activity ID.

      1) preceding and succeeding activities
      2) activity constraints

4. The schedule reports shall include a calendar in workdays.

E. Durations

1. Durations shall be in working days and shall not exceed ten (10) workdays, except for submittal and delivery items. Where the duration of continuous work exceeds ten (10) workdays, work items in the Construction Schedule shall be subdivided by location, approximate stationing or other sub-element of the work.

F. Network Activities

1. Detailed network activities shall include:

   a. The submittal and approval of samples and equipment, fabrication of special material and equipment and their installation and testing.
   b. The critical path shall be shown on all reports and on the graphic network logic diagram. The activities which constitute the critical path shall be identified.
   c. Progress milestone events or other significant stages of completion, as defined in the General Conditions and Section 01010-2.0, WORK SEQUENCE AND

CONSTRAINTS. System shutdown and tie-in dates must be specifically and conspicuously identified and included on the schedule.

d. The lead time required for testing, inspection and other procedures required prior to acceptance of the work.

e. The activity numbers shall be grouped by work area, trade and subcontractor to provide logical summary activities.

f. All activities of the Owner and the Construction Manager that affect progress along with required contract dates for completion of all parts of the work. The selection and number of activities shall be subject to favorable review by the Construction Manager.

G. Float

1. “Total Float" or “Float” shall be defined as the difference between the early finish and late finish dates for an activity.

2. On the CPM Schedule delineate the specified Contract duration and identify the planned completion of the Work as the final finish milestone. The time period between these two dates, if any, shall be considered Contract float.

3. If the Contractor’s schedule is based on less time than the maximum time allowed for milestone(s) or Contract completion no compensation for indirect overhead expenses will be considered until the expiration of the entire time periods provided for in the Contract as adjusted by any time extensions granted other than compensable time extensions. In such case refer to Article 5.3 of the General Conditions for further provisions on the reimbursement of indirect overhead expenses.

4. Float in any activity, milestone completion date or Contract completion date shall be considered a resource available to both the Owner and the Contractor. Neither the Owner nor the Contractor has ownership of the float. Float is for the benefit of the Project.

5. Acceptance of the Contractor’s Base CPM Schedule, monthly updates or revised schedule, when based on less time than the maximum time allowed for milestone(s) or Contract completion does not serve to change any Contract duration, nor serve as a waiver of the Contractor’s nor the Owner’s right to utilize the full amount of time specified in the Contract, unless so modified in a Contract Change Order.

PART 4 WEATHER CONDITIONS

Seasonal weather conditions shall be considered in the planning and scheduling of work activity durations influenced by high or low ambient temperatures or precipitation to ensure the completion of the Work within the Contract Time. Should inclement weather conditions or the conditions resulting from weather prevent Contractor from proceeding with seventy-five (75) percent of the normal labor and equipment force engaged in the current critical activity item for a period of at least five (5) hours per day toward completion of such operation or operations, and the crew is dismissed as a result thereof, it shall be an Excusable Delay in accordance with Article 5.3 of the General Conditions. Contractor may be granted a time extension pursuant to Section 5.3 of the General Conditions.

PART 5 UPDATES

5.1 SUBMITTAL PERIOD

The Contractor shall submit at monthly intervals a report of the actual construction progress. Each monthly report shall cover a period of approximately thirty (30) days. The monthly reports shall be submitted within ten (10) days of the end of the reporting period. The end of the reporting period shall be as agreed upon by the Construction Manager and Contractor.

Produce and provide one (1) complete set each of time-scaled logic diagrams and bar chart on 22-inch by 34-inch sheets. The network diagram shall be clear and legible. Critical activities shall be indicated in red color. Progress bars shall be conspicuously identified by color other than red, black or white.

A. All Monthly Updates - All monthly updates shall include as a minimum:

1. Reports - Provide the reports defined in Section 01310-3.3.4, Reports.

2. Narrative and Tabular Report - The report shall show the activities or portions of activities completed during the reporting period. The report shall state the percentage of the work actually completed and scheduled, the remaining duration, and the progress along the critical path in terms of days ahead or behind the allowable dates as of the report date. Any changes made by the Contractor to the CPM schedule, including activity numbers, durations, constraints and activity descriptions, shall be listed in a detailed report which describes the reason for each.

3. Activity Numbers and Descriptions – New activity numbers and descriptions may be added where required to further define the work and as approved by the Construction Manager. Activities may be deleted if the applicable work has not been performed and is deleted from the Work and as approved by the Construction Manager.

B. Delayed Schedule Updates - If, in the opinion of the Construction Manager, the project is behind schedule, the monthly report shall include a revised network logic diagram and/or tabular reports showing the Contractor's proposed revised CPM schedule. The CPM schedule shall be revised under the conditions defined in Section 01310-5.3, Schedule Revisions. An analysis of the effect that the delay has on progress along other paths shall also be included in the report. The Contractor shall also submit a narrative report with each updated analysis which shall include but not be limited to, a description of current and anticipated problem areas, delaying factors and their impact, and an explanation of corrective actions taken or proposed.

5.2 SCHEDULE REVIEW

Once each month, on a date mutually agreed upon, but no later than ten (10) days after the submittal of the monthly update specified herein, a jobsite meeting will be held to review the CPM Schedule, job progress and the monthly update, or the Construction Manager will provide written comments on the monthly update.

5.3 SCHEDULE REVISIONS

The conditions under which the Construction Manager will require revisions of the CPM Schedule include the following:

A. When delay in completion of any work item or sequence of work items results in an estimated extension of project completion by either twenty (20) working days or by five percent (5%) of the remaining duration of time to complete the Contract, whichever is less.

B. When delays in submittals or deliveries make replanning or rescheduling of the work necessary.

C. When the schedule does not represent actual prosecution and progress of the work.

D. When any change to the sequence of activities, the completion date for major portions of the Work, or changes occur which affect the critical path.

E. When Contract modification necessitates schedule revision.

PART 6 TIME IMPACT ANALYSES

When change orders are initiated, delays are experienced, or the Contractor desires to revise the schedule logic, the Contractor shall submit to the Construction Manager a written Time Impact Analysis illustrating the influence of each change, delay, or Contractor request on the current contract schedule completion date.

6.1. **CPM Schedule - Analysis**

a. Each Time Impact Analysis shall include a fragmentary network analysis demonstrating how the Contractor proposes to incorporate the change order, delay, or Contractor request into the CPM Schedule.

b. The analysis shall demonstrate the time impact based on the date of occurrence of the change, delay or revision; the status of construction at that point in time; and the event time computation of all affected activities.

c. The event times used in the analysis shall be those included in the latest updated copy of the CPM Schedule or as adjusted by mutual agreement between the Construction Manager and Contractor.

6.2 Activity time delays will not automatically mean that an extension of Contract Time is warranted or due the Contractor.

a. It is possible that an excusable delay or contract modification will not affect existing critical activities or cause noncritical activities to become critical, i.e., a delay or modification may result in only absorbing a part of the available total float that may exist within an activity chain of the network, thereby not causing any effect on the Contract completion date or time.

b. The Contractor acknowledges and agrees that mitigation for delays due to changes, differing site conditions, and other causes will require revision of preferential sequences of the Work. Accordingly, to mitigate delays, the activities shall be resequenced prior to the Contractor proposing an updated schedule which supports a delay to the Project as a whole. When a delay to the Project as a whole can be avoided by revising preferential sequencing, and the Contractor chooses not to implement the revisions, the Contractor will be entitled to a time extension but is not entitled to compensation for indirect overhead for this extended duration.

c. Actual delays in activities which do not affect the critical path work or which do not move the Contractor's planned completion date beyond a milestone or the Contract completion date will not be the basis for an adjustment to the Contract Time.

d. Extensions of time can be granted for a delayed or impacted activity only for the duration of the time adjustment which exceeds the total float for the schedule path wherein the activity is located. The adjustment is only applicable during the time the delay occurred or when the change is ordered.

6.3 Time Impact Analysis shall be submitted in triplicate and within fifteen (15) days after a delay occurs or with the Contractor's cost proposal in response to a notice of change from the Construction Manager. In cases where the Contractor does not submit a Time Impact Analysis for a specific change order, delay, or other Contractor requested time extension within the specified period of time, then it is mutually agreed that the particular change order, delay, or Contractor request has no time impact on the Contract completion date and no time extension is required.

a. Approval or rejection of Time Impact Analyses by the Construction Manager and the Owner will be made within fifteen (15) days after receipt of the Time Impact Analysis unless subsequent meetings and negotiations are necessary.

b. Upon approval, a copy of the Time Impact Analysis signed by the Construction Manager and Owner will be returned to the Contractor.

c. Upon mutual agreement by both parties, schedule revisions illustrating the influence of change orders, delays, and/or Contractor requests will be incorporated into the next schedule update.

PART 7 WEEKLY ACTIVITIES PLAN

On the last working day of every week the Contractor shall submit to the Construction Manager the Contractor's Plan of Activities for the next three weeks. The Plan of Activities shall describe the activity and location of the activity and include the activity number as provided in the CPM Schedule.

END OF SECTION

SECTION 01340 - SHOP DRAWINGS, PRODUCT DATA AND SAMPLES

PART 1 SUBMITTALS

1.1 GENERAL

Where the Contractor is required by these Specifications to make submittals, they shall be made to the Construction Manager with a letter of transmittal and in accordance with the requirements of this section.

Submittals shall be transmitted via a web-based database as Specified in Section 01210, Project Document Control System.

The Contractor shall submit to the Construction Manager electronic copies of the following items listed immediately below. An electronic copy of submittals which require review will be returned to the Contractor with review comments, if any, noted. Reviewed copies of the construction schedule and the Final Operation and Maintenance Manuals will not be returned to the Contractor. It shall be the Contractor's responsibility to copy and/or conform reviewed submittals in sufficient numbers for its files, subcontractors, and vendors.

Contractor’s Representative
Safety Program
Safety Supervisor
Designated “Competent Person(s)”
Substitutions
Shop Drawings
Material Safety Data Sheets
Operation and Maintenance Manuals
Working Drawings
Warranty Data
Others as Specified in the Technical Specifications

1.2 CONTRACTOR’S RESPONSIBILITIES

The Contractor shall submit, at its own expense, submittals and details of structural and reinforcing steel, equipment, material, electrical controls, architectural fabrications, pipe, pipe joints, special pipe sections, and any other appurtenances as required in technical specifications.

All submittals and supporting data, catalogs, schedules, etc., shall be submitted as the instruments of the Contractor, who shall be responsible for their accuracy and completeness and coordination. Such responsibility shall not be delegated in whole or part to subcontractors or suppliers. These submittals may be prepared by the Contractor, subcontractors, or suppliers, but the Contractor shall ascertain that submittals meet all of the requirements of the Contract Documents, while conforming to structural, space, and access conditions at the point of installation. Designation of work "by others," if shown in submittals, shall mean that the work will be the responsibility of the Contractor rather than the subcontractor or supplier who prepared the submittals. The Contractor shall insure that there is no conflict with other submittals and notify the Construction Manager in each case where its submittal may affect the work of another contractor or the Owner. The Contractor shall insure coordination of submittals among the related crafts and subcontractors. The Contractor accepts the responsibility and expense for

additional costs and delays which may result from Work performed without favorably reviewed submittals.

Submittals shall be prepared in such form that data can be identified with the applicable Specification paragraph. The data shall clearly demonstrate compliance with the Contract Plans and Specifications and shall relate to the specific equipment to be furnished. Where manufacturer's standard drawings are employed, they shall be marked clearly to show what portion of the data is applicable to this project.

PART 2 MATERIAL AND EQUIPMENT SUBSTITUTIONS

2.1 GENERAL

In preparing these Specifications, the Engineer has named those products, which to its knowledge meet the Specifications and are equivalent in construction, functional efficiency, and durability.

Wherever catalog numbers and specific brands or trade names preceded by "similar and equal" or followed by the designation "or equal" are used in conjunction with a designated material, product, thing, installation, or service mentioned in these Specifications, they are used to establish the standards of quality and utility required.

The first-named manufacturer is the basis for the project design and the use of alternative-named or unnamed manufacturer's products proposed by the Contractor may require modifications in the project design and construction. Where only one product has been named by brand, it is the only brand, trade name, or manufactured product known to the Engineer that meets these Specifications.

The equipment shown on the Drawings are based on the supply of the first-named supplier. The supplied equipment shall fit within the building or area shown on the Drawings while also maintaining the level of accessibility and clearances shown on the Drawings. If the Contractor selects a System Supplier other than the first-named System Supplier, Contractor shall be responsible for the cost of all modifications required to provide the accessibility and clearance requirements and modifications required of equipment at no additional cost to the Owner. Such changes to the layout shall not impair the equipment accessibility or limit maintenance access as generally indicated on the Drawings, nor shall it relieve the System Supplier’s responsibility for meeting the requirements of the Contract Documents. Any re-design of the equipment structure, foundation, support utilities, or any other related infrastructure needed to accommodate other than the first-named supplier shall be borne by the Contractor, without additional cost to the Owner; any such re-design of related infrastructure shall be by the Owner’s design engineer.

The Owner has made a determination that no substitution will be considered and that the following listed materials and/or equipment must be furnished as designated below in order to match others in use by the Owner or because it is a unique or novel product application required to be used by the Owner:

1. Secondary Clarifier Mechanism (Ovivo/Eimco) – Match Existing
2. Filter Feed Pump (Flygt) - Match Existing
3. RAS Pumps (Fairbanks Morse) - Match Existing
4. Scum Pumps (NOV/Moyno) - Match Existing

2.2 SUBSTITUTIONS

Substitutions which are equal in quality and utility to those specified will be permitted, subject to the following provisions. Sufficient data, drawings, samples, literature, calculations, or other detailed information as will demonstrate to the Engineer that the proposed substitute is equal in quality and utility to the material specified shall be appended to this list. The Engineer will favorably review in writing such proposed substitutions as are, in its opinion, equal in quality to the items or materials specified.

Insufficient product data and other related information which does not permit an informed evaluation is an adequate basis for rejection of the proposed substitution.

Failure of the Contractor to submit proposed substitutions for review in the manner described above shall be sufficient cause for rejection by the Construction Manager of any substitutions otherwise proposed.

2.3 MODIFICATIONS AND COSTS

If alternative named or substitutions are proposed by the Contractor and favorably reviewed by the Engineer, the Contractor is responsible for providing, at no additional cost to the Owner, any electrical, mechanical, structural, or other related changes or testing that may be required to accommodate or provide the particular material or equipment the Contractor desires to use. Any deviation from the Specifications or the Drawings resulting from the type of material or equipment to be used shall not be the basis for any "extra charges" above and in excess of the original bid price of the work.

In addition the Contractor is responsible for all additional costs to the Owner, and its agents and representatives, for evaluation of data submitted by the Contractor for alternative named or substitutions and any redesign necessary. The Owner shall deduct said costs from the Contract monies due the Contractor.

PART 3 SUBMITTAL AND MATERIAL LIST

Within ten (10) days of the Notice of Award the Owner will provide the Contractor with a Preliminary List of anticipated submittals. This list is intended as a reference to assist the Contractor in the submittal process and may not include all submittals required by the Contract. Accordingly, the Contract requirements shall govern over the Owner provided Preliminary List.

Within five (5) days after the Notice to Proceed and prior to the submission of the initial shop drawings, the Contractor shall submit a complete list of all required submittals to the Construction Manager for favorable review. The Submittal and Material List shall include a description of each item, Specification reference and the anticipated submittal date. The List shall include all items of equipment and materials for architectural, structural, mechanical, piping, electrical, heating and ventilating, equipment piping, and plumbing work; and the names of manufacturers with whom purchase orders have been placed. Items on the List shall be arranged in the same order as in these Specifications, and shall contain sufficient data to identify precisely the items of material and equipment the Contractor proposes to furnish. The List shall reference the applicable Specification section or Drawing. After the submission is favorably reviewed and returned to the Contractor by the Construction Manager, it shall become the basis for the submission of detailed manufacturer's drawings, catalog cuts, curves, diagrams, schematics, data, and information on each separate item for review. No work shall proceed on any item until it has been submitted and favorably reviewed. An incomplete submittal list is not a basis for avoiding a submittal required by the specifications.

PART 4 TRANSMITTAL PROCEDURES

4.1 TRANSMITTAL FORM

A separate transmittal form shall be used for each specific item, class of material, equipment, and items specified in separate, discrete sections, for which the submittal is required. Submittal documents common to more than one piece of equipment shall be identified with all the appropriate equipment numbers. Submittals for various items shall be made with a single form when the items taken together constitute a manufacturer's package or are so functionally related that expediency indicates checking or review of the group or package as a whole. The specification section and subsection or paragraph to which the submittal is related shall be indicated on the transmittal form.

A unique number, sequentially assigned, shall be noted on the transmittal form accompanying each item submitted. Original submittal numbers shall have the following format: "XXX"; where "XXX" is the sequential number assigned by the Contractor. Resubmittals shall have the following format: "XXX-Y"; where "XXX" is the originally assigned submittal number and "Y" is a sequential letter assigned for resubmittals, i.e., A, B, or C being the 1st, 2nd, and 3rd resubmittals, respectively. Submittal 25B, for example, is the second resubmittal of submittal 25.

4.2 DEVIATIONS FROM THE CONTRACT

If the submittals show any deviations from the Contract requirements, the Contractor shall submit with the submittal submission a separate written description of such deviations and the reasons therefor. If the Owner accepts such deviation, the Owner shall issue an appropriate Contract Change Order, except that, if the deviation is minor, or does not involve a change in price or in time of performance, a Change Order need not be issued. If any deviations from the Contract requirements are not noted on the submittal, the review of the shop drawing shall not constitute acceptance of such deviations.

4.3 SUBMITTAL COMPLETENESS

The Contractor shall review and check all submittals before submitting them to the Construction Manager. The Contractor shall stamp and certify on the transmittal letter and on each shop drawing that they have been checked, are in compliance with the Plans and Specifications, and all deviations from the Contract requirements are noted.

If the Contractor submits an incomplete submittal, the submittal will be returned to the Contractor without review. A complete submittal shall contain sufficient data to demonstrate that the items comply with the Specifications, shall meet the minimum requirements for submissions cited in the technical specifications, shall include materials and equipment data and seismic anchorage certifications where required, and shall include any necessary revisions required for equipment other than first named.

It is considered reasonable that the Contractor shall make a complete and acceptable submittal to the Construction Manager at least by the second submission of data. The Owner reserves the right to deduct monies from payments due the Contractor to cover additional costs of review beyond the second submission.

4.4 SUBMITTAL PERIOD

The Contractor shall submit the intended schedule for submission of the major submittals as defined in Section 01310, Progress Schedules. Submittals shall be submitted in time to allow

appropriate time for review and response to submittals as provided for herein prior to the incorporation of materials and equipment in the Work.

4.5 ALTERNATE SUBMITTALS

If a submittal is approved and the Contractor elects to submit an alternate item for review for the same application, the Contractor shall be responsible for the review costs for the alternate submittal.

PART 5 REVIEW PROCEDURE

Submittals shall be submitted to the Construction Manager for review and returned to the Contractor within 30 days after receipt. When a submittal cannot be returned within this period, the Construction Manager will within a reasonable time after receipt of the submittal give notice of the date by which that submittal will be returned. Review of submittals by the Engineer has as its primary objective the completion for the Owner of a project in full conformance with the Contract Documents, unmarred by field corrections, and within the time provided

After review by the Engineer of each of the Contractor's submissions, the material will be returned to the Contractor with actions defined as follows:

A. **NO EXCEPTIONS NOTED** - Accepted subject to its compatibility with future submissions and additional partial submissions for portions of the work not covered in this submission. Does not constitute approval or deletion of specified or required items not shown in the partial submission.

B. **MAKE CORRECTIONS NOTED (No resubmission required)** - Same as A, except that minor corrections as noted shall be made by the Contractor. Contractor shall provide partial resubmittal where required by the review comments.

C. **AMEND & RESUBMIT** - Rejected because of major inconsistencies or errors which shall be resolved or corrected by the Contractor prior to subsequent review by the Engineer.

D. **REJECTED - RESUBMIT** - Submitted material does not conform to Plans and Specifications in major respect. (i.e., wrong size, model, capacity, or material.)

Items A and B above (no resubmittal required) are considered "favorable review." Items C and D above (correction and resubmittal required) are considered "unfavorable review."

PART 6 EFFECT OF REVIEW OF CONTRACTOR'S SUBMITTALS

The Engineer's favorable review of submittals shall be obtained prior to the fabrication, delivery and construction of items requiring submittal review.

The favorable review of all submittals by the Engineer shall apply in general design only and shall in no way relieve the Contractor from responsibility for errors or omissions contained therein. Favorable review by the Engineer shall not relieve the Contractor of its obligation to meet contractual requirements, safety requirements and all other requirements of laws, nor constitute a Contract Change Order. Favorable review will not constitute acceptance of any responsibility for the accuracy, coordination, and completeness of the submittals or the items of equipment represented on the submittals.

PART 7 SEISMIC DESIGN AND WIND CRITERIA

7.1 SEISMIC DESIGN CRITERIA

See Section 01612 includes Seismic Design Criteria

7.2 SEISMIC WIND CRITERIA

See Section 01614 includes Seismic Wind Criteria

END OF SECTION

SECTION 01350 – STORMWATER POLLUTION PREVENTION MEASURES

PART 1 GENERAL

1.1 SECTION INCLUDES

A. Stormwater General Permit.

B. SWPPP Implementation.

C. Submittals.

D. Training.

E. Construction Site Monitoring Program.

F. Sampling.

G. Construction.

H. Payment.

1.2 STORMWATER GENERAL PERMIT

A. This project requires coverage under the State Water Resources Control Board Order No. 2009-0009-DWQ, (as amended by 2010-0014-DWQ and 2012-006-DWQ), National Pollutant Discharge Elimination System General Permit No. CAS000002, Waste Discharge Requirements for Discharges of Storm Water Runoff Associated with Construction and Land Disturbance Activities (General Permit). The above referenced Orders can be found here: http:www.waterboards.ca.gov/water_issues/programs/stormwater/constpermits.shtmh.

B. This Section includes specifications for developing, implementing and maintaining a Stormwater Pollution Prevention Plan (SWPPP) required by this General Permit.

C. This project has been determined to be a Risk Level 1 traditional construction project. A Notice of Intent for coverage under the General Permit will be filed and paid for by the City of Brentwood.

D. The City has prepared a SWPPP for this project. It is the Contractor's responsibility to implement the SWPPP and keep it up to date. The Contractor shall provide a SWPPP amendment prior to starting work. The amendment shall include, at a minimum, a list of subcontractors will be working on the project, the name of the Contractor's Project Manager and other responsible personnel, the name of the Contractor's Qualified SWPPP Practitioner (QSP), location of staging area, schedule and any initial changes anticipated to the Water Pollution Control Drawings contained in the SWPPP.

E. The Contractor's QSP or authorized representative will be responsible for providing all necessary reporting and monitoring to keep in compliance with the SWPPP and General Permit.

F. Information on stormwater Best Management Practices (BMPs) can be found in the California Stormwater Quality Association (CASQA) Stormwater Best Management Practice Handbook Portal: Construction (July 2012).

G. All discharges of stormwater from the project must comply with the General Permit.

H. A stormwater annual report shall be prepared and submitted by the Contractor. The annual report must cover the preceding period from July 1st to June 30th (or Notice of Completion date). Multiple reports may be necessary during the course of the project if the project will cover more than one fiscal year, defined as July 1 to June 30.

I. The Contractor will be responsible for designating a Data Entry Person who will upload necessary reports and documents to the State SMARTS system to comply with the General Permit.

J. Do not start job site activities until:

1. The SWPPP Amendment is authorized.

2. The waste discharge identification number (WDID) is issued.

3. Appropriate QSP and inspection personnel are identified.

K. A copy of the current SWPPP must be kept onsite at all times. The Contractor shall be responsible for keeping the SWPPP and drawings updated and providing all required inspection and monitoring reports and Rain Event Action Plans (REAPs) onsite.

1.3 SWPPP IMPLEMENTATION

A. Amendments to the SWPPP shall be prepared by a Qualified SWPPP Developer (QSD) as defined in the General Permit, Section VII.B.1.

B. The Contractor shall provide a QSP, as defined in the General Permit, Section VII.B.3, to ensure full compliance with the General Permit and implementation of all elements of the SWPPP, including all stormwater inspections and visual observations, sampling and analysis, and record keeping. The QSP shall notify the QSD of needed revisions to the SWPPP to reflect current conditions and all proposed changes.

C. This work includes gathering and presenting, in an approved format, all information necessary to produce a SWPPP that complies with the General Permit. SWPPP amendments shall be developed by a QSD and ensure that the SWPPP is maintained in compliance with the General Permit.

D. The SWPPP shall be updated to reflect current project conditions, personnel, schedule, alterations to plans, BMP modifications or substitutions, relocation of staging and material stockpiling areas and any other changes that are not reflected in the SWPPP.

1.4 SUBMITTALS

A. Submit one copy of the SWPPP Amendment for review within 10 days of Contract approval. Allow 10 days for the City's review. The Engineer provides comments and specifies the date when the review stopped if revisions are required.

B. Change and resubmit a revised SWPPP Amendment within 5 days of receiving the Engineer's comments. The City's review resumes when a complete SWPPP Amendment has been resubmitted.

C. When the Engineer authorized the SWPPP Amendment, upload an electronic copy to the State Storm Water Multiple Application and Report Tracking System (SMARTS) and submit 4 printed copies to the City.

D. If the Engineer requests additional changes to the SWPPP based upon Regional Water Quality Control Board comments, amend the SWPPP within 5 days.

E. Submit product cut sheets and technical information within 10 days of Contract approval for all materials to be used onsite such as fiber roll, silt fence, gravel bags, check dams, temporary cover, temporary hydraulic mulch bonded fiber matrix, temporary concrete washout, inlet protection, etc. Allow 10 days for the City's review.

1.5 TRAINING

A. Employees must receive initial water pollution control training before starting work at the job site.

B. For project managers, supervisory personnel, subcontractors, and employees involved in water pollution control work:

1. Provide storm water training in the following subjects:

   a. Water pollution control rules and regulations
   b. Implementation and maintenance for:
   c. Temporary soil stabilization
   d. Temporary sediment control
   e. Tracking
   f. Wind erosion control
   g. Material pollution prevention and control
   h. Waste management
   i. Non-storm water management

2. Conduct weekly training meetings covering:

   a. Deficiencies and corrective actions for water pollution control practices
   b. Water pollution control practices required for work activities during the week
   c. Spill prevention and control
   d. Material delivery, storage, usage and disposal
   e. Waste management
   f. Non-storm water management procedures

C. Document storm water training and keep a copy onsite at all times.

1.6 CONSTRUCTION SITE MONITORING PROGRAM

A. The SWPPP includes a Construction Monitoring Program containing instructions and forms. Monitoring and inspections will take place during normal working hours, excluding holidays and weekends unless work is occurring during those days. Normal working hours are assumed to be Monday through Friday 7:00 am to 4:00 pm unless otherwise specified.

B. BMP inspection shall be performed by a QSP and documented on an approved form. A copy of the inspections will be kept in the SWPPP onsite. An additional copy shall be given to the City. Noted deficiencies shall be brought to the Contractor's attention and

Engineer and corrective action shall be initiated within 72 hours. Corrective actions must be completed prior to rain or within 3 business, whichever is less.

C. Monitor the National Oceanic and Atmospheric Administration (NOAA) weather forecast daily. Printed copies of the forecast shall be kept in the SWPPP.

D. Use the Stormwater BMP Site Inspection Report form for document site inspections.

E. Inspections of BMPs identified in the SWPPP shall be done:

1. At least once a week, dry weather or rainy season;

2. Before a forecasted storm event;

3. After a qualifying rain event that produces site runoff;

4. At 24-hour intervals during extended storm events;

5. Quarterly for non-stormwater discharges.

F. Daily inspections shall be performed of:

1. Storage areas for hazardous materials and waste;

2. Hazardous waste disposal and transporting activities;

3. Hazardous material and delivery and storage activities.

G. Inspections shall also be performed of:

1. Vehicle and equipment cleaning facilities;

   a. Daily if vehicle and equipment cleaning occurs daily
   b. Weekly if vehicle and equipment cleaning does not occur daily

2. Vehicle and equipment maintenance and fueling areas

   a. Daily if vehicle and equipment maintenance and fueling occur daily
   b. Weekly if vehicle and equipment maintenance and fueling does not occur daily

3. Rain event inspections shall be performed as follows:

   a. A pre-storm inspection shall be performed within 48 hours of a forecasted storm event with 50% or more chance of occurrence.
   b. Daily during extended rain events.
   c. A post storm inspection shall be performed within 48 hours following a qualifying rain event. A qualifying rain event is one that produces 0.5 inches of rain or more with 48 hours of dry weather in between.

H. This work includes providing a QSP, performing weekly and rain event BMP inspections, documentation, coordinating with the Contractor and project inspector, providing the QSD with SWPPP update information and all other work necessary to comply with the inspection requirements of the SWPPP.

1.7 SAMPLING

A. The QSP shall perform monitoring for breaches or spills of non-visible pollutants; samples for non-visible pollutants shall be collected for lab analysis if required such as when contaminants are discharged into the storm drain system or Waters of the State.

B. Discharge locations shall be marked on the site map in the SWPPP. All sampling reports shall be kept with the SWPPP onsite and a copy provided to the Engineer. Sampling reports shall include the date, location, time, and measurement data.

1.8 CONSTRUCTION

A. The SWPPP shall be updated to reflect current project conditions, personnel, schedule, alterations to plans, BMP modifications or substitutions, relocation of staging and material stockpiling areas and any other changes that are not reflected in the SWPPP or on the plans. A printed copy of the authorized SWPPP and amendments shall be at the jobsite at all times.

B. The Contractor shall:

1. Install appropriate BMP materials and devices as listed in the SWPPP and shown on the Temporary Erosion Control Plans, before performing work activities.

2. Install soil stabilization materials (BMPs) in all work areas that are inactive or before forecasted storm events.

3. Repair or replace water pollution control practices within 72 hours of discovering any damage, unless a longer period is authorized by the Engineer.

4. The City does not pay for the cleanup, repair, disposal, or replacement of BMP devices due to improper installation or Contractor negligence.

C. The QSP shall report all non-compliance to the City within 24 hours observations are made. The QSP shall be responsible for uploading all Notice of Discharge reports to the State SMARTS system within the required time frame specified in the General Permit.

PART 2 PRODUCTS

2.1 PRODUCTS

A. All BMPs defined in the SWPPP and shown on the Water Pollution Control Drawings shall be provided in accordance with the requirements of the General Permit and the Caltrans 2015 Standard Specifications. This includes but is not limited to; street sweeping, wind erosion control, trackout control, sediment controls, soil stabilization measures, waste management, and non-stormwater management.

PART 3 EXECUTION

3.1 EXECUTION

A. All BMPs defined in the SWPPP and shown on the Water Pollution Control Drawings shall be implemented onsite in accordance with the requirements of the General Permit and the Caltrans 2015 Standard Specifications. This includes but is not limited to;

street sweeping, wind erosion control, trackout control, sediment controls, soil stabilization measures, waste management, and non-stormwater management.

3.2 COMPENSATION

A. Full compensation for conforming to the requirements of this section shall be considered as paid for at the contract lump sum price for this work which shall include full compensation for all material, equipment, labor and work required as specified herein.

END OF SECTION

SECTION 01400 - QUALITY CONTROL

PART 1 INSPECTION AND TESTING

Additional requirements for tests are described in other Technical Sections of these Specifications.

1.1 GENERAL

Where the Contract Documents require work to be field tested or approved, it shall be tested in the presence of the Construction Manager or its authorized representative. The Construction Manager shall have the right to witness all on-site tests performed by the Contractor and any shop tests. The results of any tests performed by the Contractor shall be made available for the information of the Construction Manager. Inspections, tests or favorable reviews by the Construction Manager or others shall not relieve the Contractor from its obligation to perform the work in accordance with the requirements of the Contract Documents or for its sole responsibility for the quality of workmanship and materials.

Except as specifically required under the technical specifications for testing and inspection, all tests for materials furnished by the Contractor will be done in accordance with commonly recognized standards of national organizations. Where tests are to be performed by the Construction Manager or by an independent laboratory or agency, the Contractor shall furnish such samples of all materials as required by the Construction Manager without charge. The sample or samples of materials to be tested shall be selected by such laboratory or agency, or the Construction Manager, and not by the Contractor. No material for which the Contract Documents require the submittal and approval of tests, certificates of compliance or other documentation shall be incorporated in the Work until such submittal has been made and approved.

The Contractor shall provide safe access for the Construction Manager and inspectors to adequately inspect the quality of work and the conformance with the Contract Documents. The Contractor shall furnish the Construction Manager the necessary labor and facilities for such things as excavation in the compacted fill to the depths required to take samples. The Contractor shall provide adequate lighting, ventilation, ladders and other protective facilities as may be necessary for the safe performance of inspections.

Upon completion of the Work the Construction Manager will conduct a final inspection as provided for in Article 11 of the General Conditions. Records shall be available at all reasonable hours for inspection by other local or State agencies to ascertain compliance with laws and regulations.

1.2 NOTICE

The Contractor shall notify the Construction Manager in writing at least 24 hours before any field testing or special inspections are required to be performed by the Construction Manager or independent laboratory furnished by the Owner. The Contractor shall notify the Construction Manager at least two hours before any inspection is required to be performed or to witness the Contractor’s on-site field testing.

Whenever the Contractor varies the period during which work is carried on each day, the Contractor shall give due notice to the Construction Manager so that proper inspection may be

provided. Any work done in the absence of the Construction Manager shall be considered to be rejected. It will be the responsibility of the Contractor to demonstrate to the satisfaction the Construction Manager that the work meets all conditions of the specification and if such conditions are not met to remove the work.

The Contractor shall give the Construction Manager written notification at least 30 days prior to the shipment of materials and equipment to be tested and/or inspected at the point of origin. Satisfactory tests and inspections at the point of origin shall not be construed as a final acceptance of the materials and equipment nor shall such tests and inspections preclude retesting or reinspection at the site of the Work.

1.3 COSTS OF TESTING

A. The Contractor shall be responsible for, and shall pay for, all quality control and off-site tests of materials required including all source and mix design tests for the approval of soil and concrete materials. The Owner will perform the soils and concrete confirmation tests detailed in the Technical Specifications during the performance of the Work. Owner will retain and pay a qualified testing agency to perform soil compaction testing and work identified as requiring special inspections and testing as defined by UBC section 1701. All other testing required by the technical specifications shall be the responsibility of the Contractor.

B. The Contractor shall be responsible for, and shall pay for, all source quality control and all on-site tests of materials required, except those tests specifically noted to be performed and paid for by the Owner.

C. The Construction Manager shall have the authority to require additional tests or inspections due to the manner in which the Contractor executes its work. Examples of such additional tests and inspections include; tests of materials substituted for previously accepted materials, or substituted for specified materials, or retests made necessary by failure of material to comply with the requirements of the Specifications. Where such tests and inspections are required by Contract to be performed by the Owner, the Owner will pay for the additional tests and inspections but will issue an unilateral Change Order to deduct these costs from the Contract price.

1.4 WORK COVERED PRIOR TO INSPECTION AND/OR TESTING

Work requiring inspection and/or testing shall not be concealed or buried prior to the acceptance of such inspection or testing. Work covered without the favorable review or consent of the Construction Manager shall, if required by the Construction Manager, be uncovered for inspection and/or testing at the Contractor's expense.

1.5 WORK COVERED WITH PRIOR INSPECTION AND/OR TESTING

If the Construction Manager considers it necessary or advisable that covered work which was favorably inspected and tested be uncovered for reinspection and/or retesting, the Contractor, at the Construction Manager's request, will uncover, expose or otherwise make available for observation, inspection or testing as the Construction Manager may require, that portion of the work in question, furnishing all necessary labor, materials, tools, and equipment. If it is found that such work is defective, the Contractor will bear all expenses of such uncovering, exposure, observation, inspection and testing and of satisfactory reconstruction. If, however, such work is not found to be defective the Contractor will be allowed an increase in the Contract price or an extension of the Contract time, or both, directly attributable to such uncovering, exposure,

observation, testing and reconstruction, and a Change Order shall be issued for such additional work.

PART 2 TEST WATER

The Contractor shall furnish and dispose of the water which is required for testing of piping and structures. The Contractor shall dispose of all testing water without damage to property, and in accordance with applicable regulations.

END OF SECTION

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SECTION 01510 - TEMPORARY UTILITIES

PART 1 ELECTRICAL SERVICE

The Contractor shall arrange, at its own cost, with the local utility or if the work is on and confined to the plant site with the Owner to provide adequate temporary electrical service at a location acceptable to the Owner. The Contractor shall then provide adequate jobsite distribution facilities conforming to applicable codes and safety regulations and with the approval of the Owner. The Contractor shall provide all electric power required for construction, testing, general and security lighting, and all other purposes whether supplied through temporary or permanent facilities.

PART 2 WATER

The Contractor shall pay for and shall construct all facilities necessary to furnish water for its use during construction, including potable water service. Water used for human consumption shall be kept free from contamination and shall conform to the requirements of the State and local authorities for potable water. The Contractor shall pay for all water used for the Contractor's operations prior to final acceptance. For work on the Owner plant site, the Owner may provide disinfected secondary effluent for testing purposes, however the contractor is responsible for all conveyance and proper disposal of the water.

PART 3 TEMPORARY LIGHTING

The Contractor shall provide temporary lighting in all work areas sufficient to maintain a lighting level during working hours not less than the lighting required by California OSHA standards. As permanent lighting facilities are completed they may be used in lieu of temporary facilities, provided however, that bulbs, lamps or tubes of such facilities used by the Contractor shall be replaced prior to final acceptance of the Work.

PART 4 HEATING AND VENTILATION

The Contractor shall provide means for heating and ventilating all work areas as may be required to protect the Work from damage by freezing, high temperatures, weather, or to provide a safe environment for workers. Unvented direct fired heaters shall not be used in areas where freshly placed concrete will be exposed to the combustion gases until at least two hours after the concrete has attained its initial set.

PART 5 SANITARY CONVENIENCES

The Contractor shall provide suitable and adequate sanitary conveniences for the use of all persons at the site of the Work, including sewer service. Such conveniences shall include chemical toilets or water closets and shall be located at appropriate locations at the site of the Work. All sanitary conveniences shall conform to the regulations of the public authority having jurisdiction over such matters. At the completion of the Work, all such sanitary conveniences shall be removed and the site left in a sanitary condition. The Contractor's personnel are not allowed to use Owner facilities.

END OF SECTION

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SECTION 01560 - TEMPORARY CONTROLS

PART 1 TEMPORARY FACILITIES

Construction hoists, elevators, scaffolds, stages, shoring, and similar temporary facilities shall be of ample size and capacity to adequately support and move the loads to which they will be subjected. Railings, enclosures, safety devices, and controls required by law or for adequate protection of life and property shall be provided.

PART 2 STAGING AND FALSEWORK

Temporary supports shall be designed by a registered professional engineer with an adequate safety factor to assure adequate seismic and load bearing capability. If requested by the Construction Manager, the Contractor shall submit design calculations for staging and shoring prior to application of loads.

Excavation support shall be in accordance with Article 7 of the General Conditions.

PART 3 PROTECTION OF WORK, PROPERTY AND PERSONS

The Contractor shall be responsible for the care of all work until its completion and final acceptance; and the Contractor shall, at its own expense, replace damaged or lost material and repair damaged parts of the Work, or the same may be done by the Owner, and the Contractor and its sureties shall be liable therefor. The Contractor shall make its own provisions for properly storing and protecting all material and equipment against theft, injury, or damage from any and all causes. Damaged material and equipment shall not be used in the Work. The Contractor shall take all risks from floods and casualties, or for delays from such causes. The Contractor may, however, be allowed a reasonable extension of time on account of such delays, subject to the conditions hereinbefore specified. The Contractor shall remove from the vicinity of the completed work all plant, buildings, rubbish, unused material, concrete forms, sheeting or equipment belonging to the Contractor or used under its discretion during construction; and in the event of the Contractor's failure to do so, the same may be removed by the Owner at the expense of the Contractor, and the Contractor and its sureties shall be liable therefor.

The Contractor will be held responsible for and be required to make restitution, at its own expense, for all damage to persons or property caused by the Contractor or subcontractor, or the agents, or employees of either during the progress of the Work and until its final acceptance.

PART 4 FENCES

4.1 EXISTING FENCES

Existing fences enclose the existing facilities. While it may be necessary for the Contractor to remove some of the existing fences for installation of the proposed improvements, the Contractor's operations shall not reduce the present protection and security. If the present fences are removed, an equivalent temporary continuous perimeter protection shall be provided and new fence which matches the existing fence shall be installed to replace the existing fence prior to the completion of the work.

4.2 TEMPORARY FENCES

Except as otherwise provided, the Contractor shall enclose the site of the Work with a fence adequate to protect the Work and temporary facilities against acts of theft, violence, or vandalism.

In the event all or a part of the site is to be permanently fenced, this permanent fence or a portion thereof may be built to serve for protection of the Work site, provided however, that any portions damaged or defaced shall be replaced prior to final acceptance.
Temporary openings in existing fences shall be protected to prevent intrusion by unauthorized persons. During night hours, weekends, holidays, and other times when no work is performed at the site, the Contractor shall provide temporary closures or guard service to protect such openings. Temporary openings shall be fenced when no longer necessary.

PART 5 TEMPORARY ENCLOSURES

When sandblasting, spray painting, spraying of insulation, or other activities inconveniencing or dangerous to property or the health of employees or the public are in progress, the area of activity shall be enclosed adequately to contain the dust, over-spray, or other hazard. In the event there are no permanent enclosures of the area, or such enclosures are incomplete or inadequate, the Contractor shall provide suitable temporary enclosures.

PART 6 ABOVE GRADE PROTECTION

On multi-level structures the Contractor shall provide safety protection that, as a minimum, shall meet the requirements of Title 8, California Code of Regulations.

PART 7 WORKING HOURS

Construction at the treatment plant shall be allowed as specified in the Special Conditions. The work hours in the public right of way shall be governed by local permitting authority, shall not be outside the hours stated in the Special Conditions.

When approved in advance by the Owner, work on weekends or holidays shall only occur between 8:00 a.m. and 5:00 p.m. Work on weekends and holidays may or may not be approved at the Owner's sole discretion. The Contractor shall request permission in writing from the Construction Manager at least 24 hours prior to any work to be performed outside the normal working hours defined above, on weekends or holidays.

The Contractor shall be responsible for any inspection and additional administration costs incurred by the Owner, or its agents and representatives for the following conditions:

A. For work by the Contractor outside the hours defined in the Special Conditions on weekdays, or any work on weekends or holidays recognized by the Owner.

B. For overtime costs beyond ten (10) hours in any one workday shift, regardless if the ten (10) hours occur in the allowed working hours.

Such costs shall be withheld from the succeeding monthly progress payment. Any work in Section 01010, Summary of Work, specifically required to be performed outside the normal working hours is excluded from the provisions of this paragraph.

PART 8 DUST CONTROL

During the performance of all work under this Contract, the Contractor shall assume all responsibility for dust control and shall furnish all labor, equipment, and means required to carry out proper and efficient measures wherever and whenever dust control is necessary to prevent the Contractor's operations from producing dust damage and nuisance to persons and property. Unless the construction dictates otherwise, and unless otherwise approved by the Construction Manager, the Contractor shall furnish and operate a self-loading motor sweeper with spray nozzle at least once each working day to keep paved areas acceptably clean whenever construction, including restoration, is incomplete.

Any claims resulting from dust damage or nuisance shall be borne solely by the Contractor. The Contractor shall provide additional dust control as presented in environmental mitigation measures in Section 01010.

PART 9 FIRE EXTINGUISHER

Sufficient number of fire extinguishers of the type and capacity required to protect the Work and ancillary facilities, shall be provided and maintained by the Contractor in readily accessible locations.

PART 10 USE OF EXPLOSIVES

Explosives will not be permitted.

PART 11 REMOVED MATERIALS

All concrete, paving, reinforcing steel, fencing materials, rock, soil, strips, and other waste material and construction debris shall be removed from the site by the Contractor and disposed of in accordance with applicable regulations and laws.

PART 12 CONSTRUCTION CLEANING

Throughout the period of construction the Contractor shall keep the Work site; including work, storage, parking, and employee areas; free and clean of all rubbish and debris, and shall promptly remove from the site, or from property adjacent to the site of the Work, all unused and rejected materials, surplus earth, concrete, plaster, and debris. In particular the Contractor shall keep the site clean to maintain safe access and to avoid fire hazard.

PART 13 NOISE ABATEMENT

Operations at the Worksite shall be performed so as to minimize unnecessary noise. Special measures shall be taken to suppress noise during night hours. Noise levels due to construction activity shall not exceed as specified by local ordinance.

Internal combustion engines used on the Work shall be equipped with a muffler of a type recommended by the manufacturer. No internal combustion engine shall be operated without said muffler. The Contractor shall provide additional noise abatement as presented in environmental mitigation measures in Section 01010.

PART 14 DRAINAGE CONTROL

In excavation, fill, and grading operations care shall be taken to disturb the pre-existing drainage pattern as little as possible. Particular care shall be taken not to direct drainage water onto private property or into streets or drainage ways inadequate for the increase flow. Drainage means shall be provided to protect the Work. The Contractor shall provide additional drainage control as presented in environmental mitigation measures in Section 01010.

PART 15 EROSION CONTROL

15.1 All excavated areas shall be provided with temporary erosion control measures.

15.2. Temporary erosion control shall be required for all areas where natural ground cover is disturbed, all temporary excavation stockpiles, including structures and trench excavations.

15.3. Erosion control shall be by means of filter fabric fences or hay bales placed to completely circumvent the downslope side of any excavated stockpile.

15.4. Protected areas shall be regularly inspected and maintained by the Contractor during the course of the work.

15.5. All excavations, spills, and waste materials shall not be placed in areas subject to washout, flooding or natural drainage.

15.6. See Section 01060-3.0, storm water quality controls for additional requirements.

PART 16 WARNING DEVICES AND BARRICADES

The Contractor shall adequately identify and guard all hazardous areas and conditions by visual warning devices and, where necessary, physical barriers. Such devices shall, as a minimum, conform to the requirements of Cal/OSHA.

PART 17 TRAFFIC REGULATIONS

17.1 GENERAL

The Contractor shall take all necessary steps to minimize inconvenience to the general public throughout all work under this Contract. No driveways or private roads shall be blocked without notifying the property owner and access must be restored during all non-working hours. Safe access must be maintained for pedestrian traffic throughout the work area at all times.
The Contractor shall provide additional traffic measures as defined in the following environmental mitigation measures presented in Section 01010.

At least one lane of traffic in each direction must be kept open at all times unless prior approval is provided by the Owner and the Public Agency, which has authority for the right-of-way. No roads shall be blocked or made inaccessible, due to the Contractor's work, without prior written approval of the Owner and the affected agencies. More stringent requirements may be imposed in the right-of-way permits.

The Contractor shall not block or obstruct fire lanes at any time.

The Contractor shall adopt all practical means to minimize interference to traffic and inconvenience, discomfort, or damage. The Contractor shall protect against damage, any piling, duct or structures crossing trenching or encountered in the work and shall be responsible for any damage done to such structures or damage therefrom. The Contractor shall support or replace any such structures without delay and without any additional compensation, to the entire satisfaction of the Construction Manager. All obstructions to traffic shall be guarded by flagmen as required and by barriers and illuminated at night. The Contractor shall be responsible for all damage to persons and property directly or indirectly caused by its operations, and under all circumstances the Contractor shall comply with the regulations of the City or County, and the laws and regulations of the State of California, relative to safety of persons and property and the interruption of traffic and the convenience of the public within the respective jurisdiction, and the Contractor shall be solely responsible for any damages caused by failure to provide proper safety.

17.2 HAUL ROUTES

In addition to any haul routes designated in the Contract Documents, at the preconstruction conference the Contractor shall furnish evidence that the Public Agency which has authority for the right-of-ways proposed to be utilized by the Contractor for haul routes has approved the proposed route(s) for all construction traffic on the Project. Upon approval, the Contractor shall strictly adhere to that route(s) only, unless written permission is obtained from such Public Agency to change the route(s).

17.3 TRAFFIC CONTROL

Traffic control shall be in accordance with the California Department of Transportation Traffic Manual. The Contractor shall submit for approval, by the Owner and any other applicable agency, its traffic control plans prior to work on public streets.

Traffic control shall include signs, warning lights, reflectors, barriers, and other necessary safety devices and measures, including sufficient flaggers to direct vehicular traffic through the construction areas.

No material or equipment shall be stored/parked where it will interfere with the free and safe passage of public traffic, and at the end of each day's work, and at other times when construction operations are suspended for any reason, the Contractor shall remove all equipment and other obstructions from the public right-of-way.

Should the Contractor appear to be negligent in furnishing warning and protective measures, as above provided, the Construction Manager or representative permitting agency may direct attention to the existence of a hazard, and the necessary warning and protective measures shall be furnished and installed by the Contractor at its expense.

PART 18 ROADS AND FENCES

Roads subject to interference by the prosecution of the work covered by this Contract shall be kept open, and fences subject to interference shall be maintained by the Contractor during the Work and shall be replaced to their original condition unless specifically shown otherwise on the Drawings. Such signs and barricades as are required by local laws and as necessary for the safe prosecution of the Work shall be provided.

Excavated dirt shall not be stored on roads, paths, or planted areas. Care shall be taken to protect improvements.

PART 19 PARKING AND STAGING AREAS

Contractor parking and staging within the Project area shall only be allowed within the areas, if any, designated for such use by the Owner. These areas are shown on the Project Drawings. If additional area is need, Contractor shall be responsible for making such arrangements.

No parking, waiting, queuing, or similar actions, of Contractor vehicles, including personal vehicles, delivery vehicles, supplier vehicles, or contractor owned vehicles is allowed on public streets within two miles of the treatment plant entrance gate. In the event of violations, at the Construction Manger's request, the Contractor will ban the violator from work on this project for not less than 60 days.

PART 20 TREES AND SHRUBS

Except as noted on the plans, the Contractor shall not remove trees or shrubs without authorization of the Construction Manager. Injuries to tree roots and limbs shall be avoided. No roots shall be cut or limbs pruned, without prior notification to and review of Contractors proposed methods by the Construction Manager.

PART 21 OFFICE OF CONTRACTOR AT SITE

21.1 GENERAL

The Contractor shall provide a field office, equipment, furnishings, and services specified herein, for the exclusive use of the Construction Manager, during the entire time period specified below. The Construction Manager's Field Office shall be a separate unit, not attached or connected to any other structures.

21.2 SCHEDULE

The required field office, fully equipped, connected, and functioning as specified herein, shall be provided at the site indicated, ready for use by the Construction Manager within 7 days after the commencement date stated in the Notice to Proceed.

Unless released earlier by the Construction Manager in writing, said field office shall be maintained in full operation at the site with all utilities connected and operable until 45 days after the Notice of Completion has been executed or recorded. Following that time, or upon early release of the field office by the Construction Manager, the Contractor shall remove the field office within 14 days and shall restore the site occupied by said field office to the condition shown on the plans.

21.3 SUBMITTALS

The Contractor shall submit, for the Construction Manager's review, diagrams, descriptions and product information for the field office, parking area, utilities, and furnishing in accordance with Section 01300, Shop Drawings, Product Data, and Samples. The submittal shall include a site diagram that clearly shows the location of the field office, the type and extent of fencing to be used, the parking area with grading and surfacing access stairway(s). Additional dimensioned details shall show finished interior dimensions of all rooms, including the locations of all doors, windows, heating and air conditioning units, telephone and electrical outlets and a functional,

conceptual floor plan indicating the locations of all furnishings and fixtures. Detailed information on all furnishings, fixtures, utilities, and the security system shall be included with the submittal.

21.4 LOCATION

The Construction Manager's field office shall be located where shown on plans, however if not shown, shall be within 200 feet of the Contractor's field office. A well-drained, mud-free walkway is to be provided between the Construction Manager's office and the Contractor's office.

21.5 CONSTRUCTION MANAGER'S FIELD OFFICE:

Provide separate field office on Project Site for Construction Manager, as follows:

1. One (1) trailer: approximately 24 feet by 60 feet with 8 foot minimum ceiling height with four (4) offices.

2. Construction: Weathertight building constructed at the site, pre-manufactured building, or trailer.

3. Walls and Ceiling: Insulated with finished interior surfaces.

4. All floors shall have resilient floor covering.

5. Openings: At least 6 windows with horizontal adjustable blinds and 2 entrance doors, each with cylinder lock. Doors shall be keyed alike. 8 keys shall be provided. Door locks shall be provided with a number code function for locking and unlocking.

6. Security: Provide security bars on all windows and a security system. Security system shall include monitoring all doors and a motion sensor and keypad. Alarm System shall provide local audible and strobe alarm.

7. Motion sensor operated exterior lighting over each entrance door.

8. Twenty 110 volts AC duplex receptacles with at least 2 in each office.

9. Ten (10) all-weather parking spaces adjacent to the Construction Manager's field office with all-weather access from a paved road, graded to drain without ponding and with signage for indicate use for exclusive use of Construction Manager.

10. Provide all-weather access from parking spaces to both doors at the field office with a location close to one of the doors but outside the normal path of travel for all-weather boot cleaning. Provide and maintain a fixed-in-place boot cleaning brush, hose bib with hose and nozzle hooked up to water service and a location to washout mud.

21.6 ARRANGE, MAINTAIN AND PAY FOR:

1. Professional and bonded janitorial service acceptable to the Construction Manager, including dusting, floor cleaning, and trash removal and disposal minimum once per week, and monthly comprehensive cleaning, including windows during regular working hours.

2. Automatic heating, ventilating, and air conditioning equipment in good operating condition.

3. Water supply.

4. Electric wiring, power, and lighting fixtures capable of providing at least 75 foot candles of light on work surfaces.

5. Suitable restroom facilities with sinks with hot and cold water in trailer. CONTRACTOR to provide and maintain connection to local sewer or install wastewater storage tank(s). CONTRACTOR to schedule and pay for pumping and disposal of tank(s). CONTRACTOR to size tanks.

6. A continuous supply of toilet paper, paper hand towels and hand soap and air freshener for each restroom.

7. Reliable High Speed Internet Service, capable of supporting an average of 6 employees using email, internet and online document control systems and Voice-Over-IP (VOIP) phone use. Min. speed: 5 Mbps download/ 1024 kbps upload.

8. Install min. Category 5e cabling and jacks (1 per office and 4 for central space) to support computers, printers, and other network device. This cabling should be home-run to a patch panel and meet all applicable installation standards for CAT5e. Patch panel and jack locations to be coordinated with Construction Manager. Also, provide a secure, password protected, wireless network throughout the entire trailer.

9. Provide 2 telephone lines, one with a standard phone and one with a high-quality conference type phone. Use of VOIP to provide these services is acceptable. Locations to be coordinated with the Construction Manager.

21.7 OFFICE FURNISHINGS:

The Contractor shall provide furnishings as listed below. Previously used furnishings, in good condition, as determined by the Construction Manager, are acceptable except those items specifically noted to be new. All furnishings are to be assembled, cleaned, and placed inside the office building by the Contractor, in locations directed by the Construction Manager. After the project, when released by the Construction Manager, all furnishings provided by the Contractor will become the possession of the Contractor.

1. 4 each - Desk 30x60-inch; new, HON Metro Classic Series, model # HONP3262ML; or equal.

2. 2 each - Desk 36x72-inch; new, HON Metro Classic Series, model # HONP3276ML; or equal.

3. 6 each folding tables 30” x 72”

4. 2 each folding tables 30” x 60”

5. 1 each conference table suitable for a 12’ x 12’ office and seating min. of 8 persons.

6. 8 each office chairs, standard armrest type, adjustable height, swivel, tilt-back with casters.

7. 14 each folding chairs with padded seats and backs

8. 1 drafting table not less than 36 inches by 60 inches.

9. 6 metal filing cabinets, 18 inches by 30 inches by 52 inches, 4 drawers with locks.

10. 1 supply cabinet with not less than 15 square feet of shelves.

11. 4 bookcases with not less than 12 linear feet of shelves for each bookcase

12. 4 bookcases with not less than 24 linear feet of shelves.

13. 1 plan hold rolling stands of 12 binders, with 36” binders.

14. 2 dry erase boards 96 by 48 inches, magnetic.

15. 4 dry erase boards 36 by 42 inches, magnetic.

16. Refrigerator, 19.0 cubic feet capacity.

17. Microwave oven, 1.0 cubic feet.

18. Toaster oven

19. Coffee maker

20. 1 each -Copy Machine: Ricoh model Aficio MP C5501; including copy, print, color, staple and scan functions and supporting letter, legal and 11x17 sizes; or equal. The Printer is to be networkable and include all options necessary to support that function, both wired and wireless network connections are to be provided. CONTRACTOR to provide and maintain service contract covering on-call emergency repairs, with same-day response, routine maintenance, and all toner, parts and supplies.

21. Continuous supply of Letter size, Legal size and 11x17 size paper.

22. One (1) first aid kit.

23. Fire extinguishers as required by legal requirements (min. 2 each).

24. Smoke detectors as required by legal requirements (min. 2 each).

25. One (1) two-drawer fire proof file cabinet.

26. 6 each regular waste baskets

27. 1 each large trash can with lid

28. 1 each bottled water dispenser unit (supplying both hot and cold water), new, and bottled water service delivered to the office and continuous supply of cups.

21.8 PAYMENT

Payment for the field office shall be included as a part of the payment for mobilization. No payment for mobilization, or any part thereof, will be approved for payment under the Contract until all field office facilities specified herein, have been provided.

PART 22 CONTRACTOR'S WORK AND STORAGE AREA

The Contractor shall make its own arrangements for staging, storage and shop areas necessary for the proper execution of the work.

The Contractor's construction equipment, vehicles, and materials shall not remain in public streets during non-working hours. It shall be the responsibility of the Contractor to transport and store such items at the Contractor's own facility or within construction easements on nonpublic areas at the end of each workday.

END OF SECTION

SECTION 01600 - MATERIAL AND EQUIPMENT

PART 1 SALVAGING AND STORAGE OF EQUIPMENT AND MATERIALS

Existing equipment, piping, materials, fittings and appurtenances, which are not stipulated by the Contract Documents to be reincorporated in the Work, shall be removed and properly disposed by the Contractor from the site.

PART 2 HAZARDOUS MATERIALS

All hazardous materials shall be stored and handled in strict accordance with the Material Safety Data Sheets for the products. Material Safety Data Sheets shall be submitted to the Construction Manager prior to the delivery of materials to the project. The storage and handling of potential pollution causing and hazardous materials, including but not necessarily limited to, gasoline, oil and paint shall be in accordance with all local, state and federal requirements.

PART 3 DISPOSAL OF EXCAVATED MATERIAL

The Contractor shall be responsible for making its own arrangements for disposal of all excavated material or other materials at a legal disposal site, unless onsite materials have been designated in the Contract Documents for placement or disposal at locations owned by Owner. Disposal of contaminated soil or contaminated groundwater which is encountered in the Work will be considered extra work unless such contaminated soil or groundwater is designated as such in the Contract Documents.

END OF SECTION

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SECTION 01612 – SEISMIC DESIGN CRITERIA

PART 1 GENERAL

1.1 THE REQUIREMENT

A. All products to be furnished under this contract shall be designed, constructed, and installed in conformance with the seismic requirements contained within the 2016 California Building Code (CBC), Seismic Soil Profile Type "D", and the following seismic design parameters:

1. Design Spectral Response Acceleration for Short Period (S_{DS}) = 0.956g
2. Design Spectral Response Acceleration for 1-second Period (S_{D1}) = 0.493g
3. Seismic Use Group III
4. Seismic Design Category D
5. I_E = 1.25 for entire structure
6. I_P = 1.5 for elements of structures and equipment

1.2 REFERENCE SPECIFICATIONS, CODES, AND STANDARDS

A. California Building Standards Commission (CBSC)

1. California Building Code

B. American Society of Civil Engineers (ASCE)

1. ASCE/SEI 7 – Minimum Design Loads for Buildings and Other Structures

C. American Concrete Institute (ACI)

1. ACI 318 – Building Code Requirements for Structural Concrete

D. International Code Council Evaluation Services (ICC-ES)

1. Manufacturer Evaluation Reports, as appropriate.

E. International Association of Plumbing and Mechanical Officials Uniform Evaluation Services (IAPMO-UES)

1. Manufacturer Evaluation Reports, as appropriate.

F. Sheet Metal and Air Conditioning Contractors National Association (SMACNA)

1. Seismic Restraint Manual – Guidelines for Mechanical Systems

G. Where reference is made to one of the above standards, the revision in effect at the time of bid opening shall apply.

1.3 CONTRACTOR SUBMITTALS

A. Submit calculations and/or shop drawings, in accordance with Division 1, and shall include the following information.

B. Design Data:

1. Equipment Qualification – CONTRACTOR shall submit for review and approval (if required). Structural seismic qualification of the equipment to demonstrate that it is capable of withstanding forces as specified.

2. Anchorage System – CONTRACTOR shall submit for review and approval. Structural calculations, of the proposed anchorage system, certified by a Professional Civil or Structural Engineer licensed within the State of California.

1.4 FIXTURE AND EQUIPMENT ANCHORAGE

A. Anchorage and other supports for all important equipment shall be designed to resist seismic forces occurring at each of the three principal directions separately as well as simultaneously. When combining seismic forces in the orthogonal directions simultaneously, the combination of 100-percent F_{h1}, plus 30-percent F_{h2} shall be used. Where inclusion of vertical loads results in a less conservative design, vertical effects shall be neglected. Alternatively, the orthogonal effects may be combined on a square-root-of-the-sum-of-the-squares (SRSS) basis, using 100-percent of the forces.

B. Structural design of equipment anchorage will be submitted for pre-qualified structurally rugged equipment. Calculations shall be sealed by a Civil or Structural Engineer licensed within the State of California.

C. Architectural elements (racks, shelving, cladding, windows, doors, non-engineered partition walls, parapets, ornamentation, gutters and downspouts, etc.) mechanical and electrical components, equipment housings and their attachments, supporting structures, and anchorage:

1. Shall be designed and constructed to resist the seismic forces in accordance with Chapter 16 of the CBC. This force shall be considered acting at the center of gravity of the piece under consideration. No equipment shall be anchored to vertical structural elements without written approval of the ENGINEER.

2. Component Amplification Factor (ap) equal to 2.5 for nonbuilding structures with flexible dynamic characteristics or ap = 1.0 for nonbuilding structures with rigid dynamic characteristics.

3. Vibration isolated equipment shall be provided with snubbers capable of retaining the equipment in its designated location without any material failure or deformation of the snubbers when exposed to a vertical or horizontal force at the contact surface equal to 100 percent of the operating weight of the equipment. Air gaps between retainer and equipment shall not exceed ¼-inch.

4. Piping with flexible connection and/or expansion joints shall be anchored such that the intended uses of these joints are maintained in the piping system.

5. Calculations and shop drawings shall be submitted for all anchorage details. All calculations shall be made and signed by a Professional Civil or Structural Engineer licensed in the State of California. Inasmuch as all anchorage of equipment is to be made of poured-in-place concrete elements, it is imperative that types of anchorage be coordinated with the concrete contractor so that anchorage may be installed at time of concrete placement. If calculations and anchorage details are not submitted prior to placing concrete, the CONTRACTOR will become responsible for any strengthening of concrete elements because of superimposed seismic loading.

D. Cast-in anchor bolts are preferred for support of critical equipment and framing. Post-installed concrete anchors will not be used, without approval from the ENGINEER, for critical fastening such as extreme vibratory conditions, impact loads, seismic connections, and overhead installations.

E. Expansion and adhesive post-installed concrete anchors will have an associated research report issued by The International Code Council Evaluation Service, Inc. (ICC-ES) and/or International Association of Plumbing and Mechanical Officials Uniform Evaluation Services (IAPMO-UES). Design values and installation requirements for anchors will be as presented in the appropriate ICC-ES and/or IAPMO-UES report(s). Edge distance, bolt spacing, inspection requirements and operating temperatures will be considered when determining the appropriate allowable design values.

1.5 VIBRATION ISOLATION

A. In general, equipment should be rigidly mounted to supporting foundations and structures, without the aid of vibration isolation devices. Exceptions are mechanical equipment in which vibrations transmitted from the equipment would be troubling to building occupants and/or other equipment within the building.

B. If vibration isolation mountings are required for equipment. The mountings, and their attachments to the supporting structure, shall be designed as flexible mountings in accordance with governing Code. The supplier of the vibration isolation mounting hardware shall be required to submit certified calculations, sealed by a Civil or Structural Engineer licensed within the State of California. Indicating the adequacy of the hardware and attachment anchorage to meet these criteria.

1.6 ABOVE GROUND PIPING

A. Steel piping shall as a minimum, be provided with braces that satisfy the latest edition of SMACNA requirements for Seismic Hazard Level A unless demonstrated to the satisfaction of the CITY that it is capable of resisting the required seismic forces under other support conditions. Connection Level I shall be used for all piping.

B. Plastic piping shall be braced laterally at intervals not exceeding twice that recommended by the manufacturer for vertical support.

C. Piping crossing expansion joints between adjacent structures shall be provided with expansion fittings, multiple bends, or other suitable provisions to ensure capacity to sustain expected differential movement between structures.

PART 2 PRODUCTS

NOT USED

PART 3 EXECUTION

3.1 GENERAL

A. All equipment designed to be fixed in position shall be securely fastened in place in conformance with the CBC, ASCE 7, or as specified herein the Technical Specifications for a specific piece of equipment under Division 2 through 16. For other equipment, the equipment manufacturer shall provide recommended anchorage information to the CONTRACTOR for use in the installation of the equipment.

B. See also Section 01614 for Wind Design Criteria.

3.2 STRUCTURAL INTEGRITY AND ANCHORAGE

A. It shall be the responsibility of the equipment manufacturer/supplier to provide the engineering anchorage calculations and figures to the CONTRACTOR for submission to the ENGINEER. As a minimum, the equipment manufacturer/supplier shall determine the number, dimensions, material, location, embedment and installation conditions of all anchor bolts to be set in concrete in accordance with Contract Specifications and Drawings. At the option of the CONTRACTOR, the CONTRACTOR or equipment manufacturer/supplier shall furnish the anchor bolts and associated hardware as specified herein and as determined by the manufacturer/supplier's engineering anchorage calculations for installation by the CONTRACTOR.

B. Engineering anchorage calculations and figures shall be prepared, stamped and signed by a Professional Civil or Structural Engineer licensed in the State of California. Calculations shall include the following steps as a minimum:

1. Determination of the operating equipment weight and centroid of the equipment.

2. Determination of the shear and overturning forces at each anchorage due to the force determined, as specified below, being applied at the equipment's centroid.

3. Determination of the shear and tension forces that must be developed by the anchorage at each support to resist the forces calculated.

4. Selection of the anchorage details based upon the maximum shear and tension forces calculated above. As a minimum, details shall include number of bolts, materials, diameter, total length, embedded length, required edge distance and bolt dimensions. The embedded length of bolts shall be suitable to develop the ultimate tensile capacity of the anchorage for ductile failure.

C. For all equipment weighing 400 pounds or more, the minimum anchor bolt size shall be 5/8-inch diameter, with 5-inch minimum embedment. The minimum anchor bolt size for all other equipment shall be 3/8-inch diameter, with 4-inch minimum embedment. All anchor bolts securing equipment to be grouted shall be furnished with leveling nuts, the faces of which shall be tightened against the flat surfaces to not less than 10 percent of the bolts safe tensile stress.

D. Cast-in-place anchor bolts shall be set before concrete has been placed and shall be carefully held in position with suitable templates of an acceptable design.

E. No equipment shall be anchored to vertical structural elements without the written approval of the ENGINEER, with the exception of pipe hangers/supports or anchorage as specified.

3.3 SEISMIC REQUIREMENTS

A. The seismic qualification for the above equipment shall be demonstrated by structural calculation(s) or engineering shake table test(s).

3.4 PROOF OF COMPLIANCE

A. Equipment with complex component structural systems, (i.e. systems involving components with multiple degrees of freedom and higher order modes of vibration), contains low weight components (e.g. circuit boards, relays, or solenoids), an additional empirical evaluation for such low weight components shall be certified in writing by a Professional Civil or Structural Engineer, licensed in the State of California, to satisfy the requirements set forth above. At a minimum, such certification shall be based on an empirical evaluation of direct observation of such equipment as part of the factory or shop witness testing including physical “hand” shake and pull tests, and general calculations (if required to verify capacity overload) necessary to satisfy the ENGINEER of compliance with the above requirements. Certification shall be in the form of a letter from the licensed engineer incorporating the nature of the observations and/or calculations performed including the licensed engineer’s seal and signature

END OF SECTION

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SECTION 01614 – WIND DESIGN CRITERIA

PART 1 GENERAL

1.1 THE REQUIREMENT

A. All products to be furnished under this contract shall be designed, constructed, and installed in conformance with the wind design requirements contained within the 2016 California Building Code (CBC), and the following design parameters:

1. Occupancy Category, III

2. Basic Wind Speed (3 Second Gust) 115 miles per hour

3. Wind Exposure Category "C"

1.2 REFERENCE SPECIFICATIONS, CODES, AND STANDARDS

A. California Building Standards Commission (CBSC)

1. California Building Code

B. American Society of Civil Engineers (ASCE)

1. ASCE/SEI 7 – Minimum Design Loads for Buildings and Other Structures

C. American Concrete Institute (ACI)

1. ACI 318 – Building Code Requirements for Structural Concrete

D. International Code Council Evaluation Services (ICC-ES)

1. Manufacturer Evaluation Reports, as appropriate.

E. International Association of Plumbing and Mechanical Officials Uniform Evaluation Services (IAPMO-UES)

1. Manufacturer Evaluation Reports, as appropriate.

F. Where reference is made to one of the above standards, the revision in effect at the time of bid opening shall apply.

1.3 CONTRACTOR SUBMITTALS

A. Submit calculations and/or shop drawings, in accordance with Division 1, and shall include the following information:

B. Design Data:

1. Anchorage System – CONTRACTOR shall submit for review and approval. Structural calculations, of the proposed anchorage system, certified by a Professional Civil or Structural Engineer licensed within the State of California.

1.4 FIXTURE AND EQUIPMENT ANCHORAGE

A. Anchorage and other supports for all important equipment shall be designed to resist wind forces occurring along each of the three principal directions.

B. Architectural elements (racks, shelving, cladding, windows, doors, non-engineered partition walls, parapets, ornamentation, gutters and downspouts, etc.) mechanical and electrical components, equipment housings and their attachments, supporting structures, and anchorage:

1. Calculations and shop drawings shall be submitted for all anchorage details. All calculations shall be made and signed by a Professional Civil/Structural Engineer licensed in the State of California. Inasmuch as all anchorage of equipment is to be made of poured-in-place concrete elements, it is imperative that types of anchorage be coordinated with the concrete contractor so that anchorage may be installed at time of concrete placement. If calculations and anchorage details are not submitted prior to placing concrete, the CONTRACTOR will become responsible for any strengthening of concrete elements because of superimposed wind loading.

C. Cast-in anchor bolts are preferred for support of critical equipment and framing. Post-installed concrete anchors will not be used, without approval from the ENGINEER.

D. Expansion and adhesive post-installed concrete anchors will have an associated research report issued by The International Code Council Evaluation Service, Inc. (ICC-ES) and/or International Association of Plumbing and Mechanical Officials Uniform Evaluation Services (IAPMO-UES). Design values and installation requirements for anchors will be as presented in the appropriate ICC-ES and/or IAPMO-UES report(s). Edge distance, bolt spacing, inspection requirements and operating temperatures will be considered when determining the appropriate allowable design values.

PART 2 PRODUCTS

NOT USED

PART 3 EXECUTION

3.1 GENERAL

A. All equipment designed to be fixed in position shall be securely fastened in place in conformance with the CBC, ASCE 7, or as specified herein the Technical Specifications for a specific piece of equipment under Division 2 through 16. For other equipment, the equipment manufacturer shall provide recommended anchorage information to the CONTRACTOR for use in the installation of the equipment.

B. See also Section 01612 for Seismic Design Criteria.

3.2 STRUCTURAL INTEGRITY AND ANCHORAGE

A. It shall be the responsibility of the equipment manufacturer/supplier to provide the engineering anchorage calculations and figures to the CONTRACTOR for submission to the ENGINEER. As a minimum, the equipment manufacturer/supplier shall determine the number, dimensions, material, location, embedment and installation conditions of all anchor bolts to be set in concrete in accordance with Contract Specifications and Drawings. At the option of the CONTRACTOR, the CONTRACTOR or equipment manufacturer/supplier shall furnish the anchor bolts and associated hardware as specified herein and as determined by the manufacturer/supplier's engineering anchorage calculations for installation by the CONTRACTOR.

B. Engineering anchorage calculations and figures shall be prepared, stamped and signed by a Professional Civil or Structural Engineer licensed in the State of California. Calculations shall include the following steps as a minimum:

1. Determination of the shear and overturning forces at each anchorage due to the force determined, as specified below, being applied.

2. Determination of the shear and tension forces that must be developed by the anchorage at each support to resist the forces calculated.

3. Selection of the anchorage details based upon the maximum shear and tension forces calculated above. As a minimum, details shall include number of bolts, materials, diameter, total length, embedded length, required edge distance and bolt dimensions. The embedded length of bolts shall be suitable to develop the ultimate tensile capacity of the anchorage for ductile failure.

C. Cast-in-place anchor bolts shall be set before concrete has been placed and shall be carefully held in position with suitable templates of an acceptable design.

D. No equipment shall be anchored to vertical structural elements without the written approval of the ENGINEER, with the exception of pipe hangers/supports or anchorage as specified.

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SECTION 01660 - TESTING AND TRAINING

PART 1 TESTING

1.1 CONTRACT REQUIREMENTS

A. Testing shall be performed

B. The testing on the Project shall encompass at a minimum the following and shall be performed in the following sequence:

1. Factory Performance Testing: As specified in Section 01660-1.3 and individual equipment sections in Divisions 11 and 15.

2. Installation Testing: As specified in Section 01660-1.4 and

   a. Electrical Testing (Division 16)
   b. Instrumentation and Controls Testing (Division 13)
   c. Mechanical Pre-Operational Tests (Divisions 11 and 15)

3. Functional and Equipment Testing (8-Hour Test): As specified in Section 01660-1.6

4. Operational Testing (5-Day Test): As specified in Section 01660-1.6

5. Process Testing: As specified in Section 01660-1.7

C. The Contractor shall appoint a qualified person as Testing Coordinator to manage, coordinate, and supervise the Contractor's testing program. The Testing Coordinator shall have at least five (5) years of total experience, or experience on at least five separate projects, in managing the testing and startup of mechanical, electrical, instrumentation, HVAC and piping systems for a wastewater or water treatment plant.

D. Complete testing, training, and start-up, along with full and complete documentation of these activities, within the Contract Times.

E. Testing, training, and startup shall be integrated across equipment and systems. The Contractor shall coordinate and integrate the documentation and efforts of manufacturers and subcontractors to achieve unified tests and test plans.

F. Allow realistic duration in the Progress Schedule for testing, training, start-up, and documentation activities.

G. The Contractor shall be responsible for system setup and installation of bypasses, bulkheads, temporary piping or other controls as necessary to allow the testing to be performed. Furnish labor, power, tools, equipment, instruments, and services required for and incidental to completing testing.

H. Provide competent, experienced technical representatives of equipment manufacturers for assembly, installation and testing guidance, and operator training.

I. Health and safety facilities shall be in place prior to starting testing, including fire protection, ventilation, weather protection, either temporary or permanent.

1.2 SUBMITTALS – START-UP PLAN

A. Submit start-up plan for each piece of equipment and each system not less than 70 days prior to planned initial start-up of equipment or system.

B. Include overall testing, training, and start-up activities on the project progress schedule specified in Section 01310, PROGRESS SCHEDULES. Testing, training, and start-up shall be detailed in a sub-network of the overall project progress schedule with the following activities identified:

1. Manufacturer's services.

2. Installation certifications.

3. Operator training.

4. Submission of Operation and Maintenance Manual.

5. Electrical testing

6. Instrumentation testing

7. Installation Testing

8. Functional testing.

9. Operational testing.

10. Process Testing

C. Provide testing plan with test logs for each item of equipment and each system. Include testing of alarms, control circuits, capacities, speeds, flows, pressures, vibrations, sound levels, and other parameters.

D. Contractor shall prepare functional testing plans and procedures for all project equipment and systems and for all modes of operation. Functional testing procedures shall be in the cause and effect format. The person conducting the operating test shall initiate an action (cause) and, upon the systems or subsystems producing the required result (effect), the specific test requirement will have been satisfied. A sample form illustrating this concept and which shows the level of detail required in the Contractor-developed functional testing form is appended to the end of this Section. Only computer-generated functional testing forms shall be submitted; handwritten forms are unacceptable.

E. Submittal requirements for instrumentation and controls testing are specified in Section 13400, Common Work Results Process Instrumentation and Controls Tests, include the following:

1. PLC panel shop test.

2. Unwitnessed factory test.

3. Factory demonstration test.

4. Operational readiness test.

5. Functional acceptance test.

F. Submittal requirements for mechanical equipment testing are specified in Divisions 11 and 15.

G. Submittal requirements for electrical testing are specified in Division 16.

H. Provide summary of shutdown requirements for existing systems which are necessary to complete start-up of new equipment and systems.

I. Revise and update start-up plan based upon review comments, actual progress, or to accommodate changes in the sequence of activities.

J. Contractor is responsible for regulatory non-compliance and local area complaints for noise, odors, and other nuisance conditions resulting from start-up plan actions and activities.

K. The Instrumentation and Control Systems startup plan shall be prepared by the PCSI Project Manager specified in Section 13400, Common Work Results Process Instrumentation and Controls Tests. The PCSI Project Manager shall perform other functions as specified in Section 13400.

L. The Functional and Operational Testing Plans required for Sections 01660-1.5 and 1.6 shall list the personnel who will be present to assist with and witness the tests. This list shall include the Testing Coordinator, any Contractor personnel, the Instrumentation and Control Systems Installation Supervisor, subcontractors, manufacturer's representatives, Owner staff, Construction Manager, Design Consultant, and any other required personnel.

M. The Startup Team shall jointly develop the startup plans for the Functional, Operational, and Process Testing specified in Sections 01660-1.5, 1.6 and 1.7 at least 90 days before testing is scheduled at each area. The Construction Manager will provide the individual to act a facilitator for the Startup Team. The Contractor shall have responsibility for development of the plan. The Owner will provide and designate other members of the Startup Team from the Design Consultant and Operations Staff. The Contractor's Testing Coordinator and the Instrumentation and Control Systems Installation Supervisor shall each be members of this Startup Team and shall each be dedicated a minimum of 200 hours to working directly with the Startup Team in the development of these startup plans.

1.3 FACTORY PERFORMANCE TESTING

A. Test equipment for proper performance at point of manufacture or assembly when specified.

B. When source quality control testing is specified:

1. Demonstrate equipment meets specified performance requirements.

2. Provide certified copies of test results.

3. Do not ship equipment until certified copies have received written acceptance from Construction Manager. Written acceptance does not constitute final acceptance.

4. Perform testing as specified in the equipment specification sections.

C. Contractor shall provide a minimum of 45 days written notice to the Construction Manager prior to conducting the witness performance testing.

1.4 INSTALLATION TESTING

A. Mechanical Systems: As specified in specification sections and Divisions 11 and 15:

1. Remove rust preventatives and oils applied to protect equipment during construction.

2. Flush lubrication systems and dispose of flushing oils. Recharge lubrication system with lubricant recommended by manufacturer.

3. Flush fuel system and provide fuel for testing and start-up.

4. Install and adjust packing, mechanical seals, O-rings, and other seals. Replace defective seals.

5. Remove temporary supports, bracing, or other foreign objects installed to prevent damage during shipment, storage, and erection.

6. Check rotating machinery for correct direction of rotation and for freedom of moving parts before connecting driver.

7. Perform cold alignment and hot alignment to manufacturer's tolerances.

8. Adjust V-belt tension and variable pitch sheaves.

9. Inspect hand and motorized valves for proper adjustment. Tighten packing glands to insure no leakage, but permit valve stems to rotate without galling. Verify valve seats are positioned for proper flow direction.

10. Tighten leaking flanges or replace flange gasket. Inspect screwed joints for leakage.

11. Install gratings, safety chains, handrails, shaft guards, and sidewalks prior to operational testing.

12. Implement lockout/tagout procedures.

13. Demonstrate alignment, speed, flow, pressure, vibration, sound level, adjustments, and calibration over the full operating range of equipment and systems. Perform initial checks in the presence of and with the assistance of the manufacturer's representative.

14. Other requirements as defined in the equipment Operation and Maintenance Manuals.

B. Electrical Systems: As specified in Section 13400, Common Work Results Process Instrumentation and Controls Tests, Section 16080 Electrical System Analyses and Commission Field Testing and the individual equipment specification sections.

1. Electrical testing shall consist of electrical equipment testing prior to energization and operation of electrical equipment. The following shall be submitted to Construction Manager for review prior to equipment startup and energization:

a. Completed field calibration testing data forms as specified in Section 13400.
b. Completed electrical equipment testing data forms required by Section 16080.

2. Unsatisfactory equipment test results shall require that the equipment be repaired and re-tested until acceptable results are obtained at no additional cost to the Owner.

C. Instrumentation Systems:

1. Requirements for instrumentation and controls testing are specified in in Section 13400, Common Work Results Process Instrumentation and Controls Tests.

2. Related requirements for plant control system testing are specified in Section 13490, Commissioning of Process Control Systems.

3. Certain equipment and package systems include instrumentation and controls. Refer to applicable specifications for testing requirements of these systems.

4. Instrumentation and controls testing shall not begin until design and other submittals required by Sections 13400, and 13490 have been reviewed by the Design Consultant and returned marked as “No Exceptions Noted”. Where specified as formal submittals, test procedures shall be provided sufficiently in advance of scheduled testing.

1.5 FUNCTIONAL TESTING EQUIPMENT PERFORMANCE TEST (8-HOUR TEST)

A. Functional equipment testing shall be preceded by operational readiness testing specified in Section 13400, to ensure that instrumentation and control systems are operational in advance of functional testing.

B. Functional testing and initial equipment operation test shall not begin until after the Installation Testing including the Electrical Testing has been completed for individual systems or pieces of equipment.

C. The functional stage of testing shall involve the completion of functional testing forms which include all possible operating scenarios, alarm conditions, prohibitive interlocks, and indication functions. A sample form showing the level of detail required in the Contractor-developed functional testing form is appended to the end of this Section. Contractor shall perform a “dry run” for all functional tests to ensure that systems are working properly prior to witnessing by the Construction Manager. After the “dry run” is successfully completed, Contractor shall provide minimum 48 hours notice to the Construction Manager that systems are ready for witnessed

functional testing. The Construction Manager will witness functional testing and will initial all functional testing forms upon successful operation of systems.

D. Functional testing of all process equipment shall take place with available plant effluent The Contractor is responsible for the installation and removal of any additional piping, valves, pumps, etc to deliver the test water to the process area and to discharge the water back to a location and at a rate approved by the Owner. Where due to process reasons equipment cannot be operated without sewage/sludge the Functional Testing shall be performed to the extent possible.

E. The Contractor is responsible for all costs of the functional testing(excluding power), including the supply of materials and chemicals necessary for the performance of the tests.

F. The Contractor is responsible for functional testing for all project equipment and systems in all modes of operation.

G. Demonstrate proper operation of each instrument loop function including alarms, local and remote controls, instrumentation and other equipment functions. For each item of equipment and process system, develop actual process conditions as needed to test each loop, each mode of control, sequences, alarms, and other functions specified in equipment/package specifications Section 13400 and Section 13490. Verify control system response and data display and logging at all applicable devices. Verify and record scaling and setpoints. Only where it is infeasible to develop actual process conditions, simulations may be used with test equipment.

H. Conduct continuous 8 hour test under normal operating conditions. Modify system parameters, pump and equipment control, and process treatment operations to confirm all operating parameters during this test. If any equipment or system does not meet all of the parameters defined in the Functional Test Plan, the Contractor shall correct the problem and shall repeat the test until it is successful.

I. Functional test of mechanical, electrical and instrumentation equipment required for operation of a Process area shall be completed prior to performing the operational test for the Process area.

J. Certificate of Proper Installation:

1. At completion of Functional Testing and prior to Operational Testing, furnish written report prepared and signed by manufacturer's authorized representative, certifying equipment:

    a. Has been properly installed, adjusted, aligned, and lubricated.
    b. Is free of any stresses imposed by connecting piping or anchor bolts.
    c. Is suitable for satisfactory full-time operation under full load conditions.
    d. Operates within the allowable limits for vibration.
    e. Controls, protective devices, instrumentation, and control panels furnished as part of the equipment package are properly installed, calibrated, and functioning.
    f. Control logic for start-up, shutdown, sequencing, interlocks, and emergency shutdown have been tested and are properly functioning.

2. Furnish written report prepared and signed by the electrical and/or instrumentation subcontractor certifying:

a. Control logic that resides in motor control centers, control panels, and circuit boards furnished by the electrical and/or instrumentation subcontractor has been calibrated and tested and is properly operating.
b. Control logic for equipment start-up, shutdown, sequencing, interlocks and emergency shutdown has been tested and is properly operating.

3. Co-sign the reports along with the manufacturer's representative and subcontractors.

1.6 OPERATIONAL TESTING (5-DAY TEST)

A. The Operational Test shall demonstrate satisfactory operation of equipment and systems in actual operation. Refer to Section 01010, SUMMARY OF WORK, for additional operational acceptance testing requirements. To the extent feasible areas of the plant shall be operationally tested within the Process Areas defined in Section 01660-1.7.

B. Conduct operational acceptance test for 5 sequential workdays for eight hours per day under the supervision and control of the Contractor. The test shall simulate actual operating conditions to the greatest extent possible; including the testing of all controls and programming associated with the system.

C. The Contractor is responsible for all costs of the operational testing (excluding power), including the supply of materials and chemicals necessary for the performance of the tests.

D. Operational testing of all process equipment shall take place with available plant effluent where feasible and practical and to the greatest extent possible. The Contractor is responsible for the installation and removal of any additional piping, valves, pumps, etc to deliver the test water to the process area and to discharge the water back to a location and at a rate approved by the Owner. Where due to process reasons equipment cannot be operated without sewage/sludge the Operational Testing shall be performed to the extent possible.

E. Immediately correct defects in material, workmanship, or equipment which become evident during operational test.

F. Repeat operational test when malfunctions or deficiencies cause shutdown or partial operation of the facility or results in performance that is less than specified in the Contract Documents.

G. Failure of any major process unit during the five (5)-day test will result in the abandonment of the test and the test procedures shall be restarted from the beginning.

1.7 PROCESS TESTING

A. Cleanup: Following completion of an area Operational Test, the Contractor shall remove, clean and replace all permanent and temporary filters and strainers in all pipeline systems; replace all HVAC filters, dewater and clean sumps; and dewater, where directed by the Construction Manager, all process units for final inspection as a condition precedent to proceeding with Process Testing.

B. Commissioning Team: The Contractor shall assemble under the direction of the Testing Coordinator a commissioning team. The commissioning team shall consist

of representatives of the Contractor's mechanical, electrical, and instrumentation subcontractors, and others as appropriate. The commissioning team shall be available at the site of the work during normal working hours (8 hours a day, 5 days a week, Saturdays, Sunday and legal holidays excepted) and shall be available within 2 hours notice at all other times upon notice by telephone. The commissioning team shall at all times be equipped and ready to provide for emergency repairs, adjustments, and corrections to the equipment and systems installed and modified as a part of this Contract.

C. Process testing of equipment and systems shall take place following Functional and Operational Testing at each Process area and after the Owner's staff has acknowledged in writing that they have received the necessary training for the applicable equipment and systems. The Contractor shall remove all temporary piping, bulkheads, controls and other alterations to the permanent systems that may have been needed during the Functional and Operational Testing and shall perform the tasks necessary to make the improvements constructed under this Contract fully operational. Process Testing will be performed utilizing the intended process flows.

D. All influent and effluent piping to each process area shall be in place and included in the Process Test unless the Contractor provides temporary facilities to allow complete testing and operation of the system. All permanent power facilities and controls shall be in place for the Process Test unless otherwise stipulated in the Contract Documents.

E. The Owner will provide operations personnel, power, fuel, chemicals and other consumables for the Process Testing.

F. All processes and systems shall be Process Tested during the performance of the Process Test for one of the areas defined below. Substantial Completion of an area will not be issued until after successful completion of the associated Process Test. The Process Testing shall proceed in the sequence defined below unless otherwise submitted to and approved by the Construction Manager:

1. Process Test 1, Aeration Basin 3 and 4: The Aeration Basin 3 and 4, aeration blowers, diffusers, mixers, and all associated equipment and processes shall be tested for a 45 day period. Interim controls will be allowed for this startup as provided for in Section 01010, Summary of Work, and Section 01020, Plant Control System Sequencing.

2. Process Test 2, Secondary Clarifier No. 3 and RAS PS: This test may start before Process Test 1-AB 3 and 4, if so desired by the Contractor. Secondary Clarifier No. 3, RAS Pump Station and facilities and all associated equipment and processes shall be tested for a 21 day period. Interim controls will be allowed for this startup as provided for in Section 01010, Summary of Work, and Section 01020, Plant Control System Sequencing.

3. Process Test 3, Chlorine Contact Tank: This test includes the chlorine contact tanks modifications and all associated equipment and processes shall be tested for a 30 day period. Interim controls will be allowed for this startup as provided for in Section 01010, Summary of Work, and Section 01020, Plant Control System Sequencing.

4. Process Test 4, Biosolids Dryer: The Biosolids Dryer, dewatering conveyors, and all associated equipment and processes shall be tested for a 30 day period. Interim controls will be allowed for this startup as provided for in

Section 01010, Summary of Work, and Section 01020, Plant Control System Sequencing.

5. Other Equipment/Systems: All other equipment and process systems not included in the above Process Test areas shall have a 21 day Process Test as defined herein.

G. Process testing shall be coordinated with Owner occupancy requirements as defined in Section 01010, Summary of Work,.

H. Contractor shall document modifications to process equipment made during Process and startup testing.

1.8 RECORD KEEPING

Maintain and submit following records generated during start-up and testing phase of Project:

A. Daily logs of equipment testing identifying all tests conducted and outcome.

B. Logs of time spent by manufacturer's representatives performing services on the job site.

C. Equipment lubrication records.

D. Electrical phase, voltage, and amperage measurements.

E. Insulate resistance measurements.

F. Data sheets of control loop testing including testing and calibration of instrumentation devices and set points.

PART 2 TRAINING OF OWNER PERSONNEL

2.1 GENERAL

A. Operation and maintenance training of Owner’s personnel shall be provided for all equipment identified in the technical specifications. Training content is to be tailored to the needs of the operations group and the maintenance group.

B. Training shall be conducted by competent representatives who are certified by the manufacturer to be thoroughly familiar with the subject matter as well as instructional methods.

C. These training services shall be conducted onsite by the manufacturer’s representative and shall ensure that Owner’s personnel are trained to perform equipment task requirements, including essential knowledge and skills. The Owner may conduct objective evaluations of its employees receiving this training to verify compliance with the requirement. In addition the Owner will have the trainees provide an evaluation of the trainer and the training materials. If either evaluation process determines that the training was deficient, the Contractor shall be required to have the manufacturer re-perform the training at a schedule to be defined by the Owner and with an approved representative from the factory.

D. Training materials shall be submitted to the Owner for review. Training materials shall include a list of task statements which the Owner’s employees may perform

with the equipment, the learning objectives (derived from the task list and by which the training will be evaluated) and the training plan (or lesson plan) to demonstrate how the learning objectives will be achieved. Acceptance of training materials is required prior to start of training. The Contractor shall provide an adequate number of printed trainee materials for all persons being trained. One electronic copy of training material shall be provided to the Owner.

E. The Contractor shall submit, within 180 days of Notice To Proceed, a list of all equipment items or systems for which training will be provided in accordance with the specifications. The list shall include item number, specification section, description and required training in hours.

F. The Owner shall have the right to videotape all training sessions, or may designate separate sessions or portions thereof for the sole purpose of videotaping.

2.2 TRAINING COORDINATOR

A. The Contractor shall designate and provide one or more persons to be responsible for coordinating and expediting the training duties. The person or persons so designated shall be present at all training coordination meetings with the Owner.

2.3 TRAINING SCHEDULE

A. The Contractor's coordinator shall coordinate the training periods with the Construction Manager and shall submit a training schedule and the training materials for each piece of equipment or system for which training is to be provided. Said training schedule and materials shall be submitted not less than sixty (60) calendar days prior to the time that the associated training is to be provided, and the training materials shall be approved at least twenty (20) calendar days before the associated training is provided.

B. Equipment and/or systems shall be deemed suitable for use in training upon satisfactory completion of functional testing. Training for equipment in a process system must be completed prior to commencement of the Process Test for that area.

C. Training sessions for each piece of equipment shall be four (4) hours total except as otherwise noted. Training sessions shall be scheduled on Tuesdays through Thursdays. Training sessions shall be provided during the day between the hours of 8:00 a.m. and 4:00 p.m.

D. The Contractor shall schedule separate training sessions for both operations and maintenance personnel and meet the following criteria:

1. Maintenance training shall be provided for each piece of equipment listed in the approved Operation and Maintenance manual submitted by the Contractor. Training shall emphasize theory of operations, troubleshooting, preventative maintenance, predictive maintenance, and repair procedures. The training shall encompass issues relating to instrumentation, electrical and mechanical systems.

2. Operations training shall be provided for each piece of equipment listed in the approved Operation and Maintenance manual submitted by the Contractor. Training shall emphasize theory of operations, startup and shutdown instructions, normal operation, abnormal and emergency operations (where applicable), lockout procedures, troubleshooting, preventative maintenance and alarm and control logic including fail-safe mode of operation.

E. The Contractor shall confirm each training period a minimum of three (3) working days prior to the scheduled time.

END OF SECTION

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SECTION 1660 - SAMPLE FUNCTIONAL TESTING FORM

PROCESS SYSTEM: Plant 3 Water

P&ID: P1000-1
SCHEM DIAG NO.: 900

EQUIPMENT: 09-PMP-001 3W Pump No.1
09-PMP-002 3W Pump No.2
PIT-9-3

Testing Step	Mode Set-up	Operational Test	Required Result	Initial Complete Kr	CM
1	09-PMP-001 LOR-"Off"	Depress Local Start	a. Pump does not start b. Off indic at DCS c. No Remote indic at DCS		
2	09-PMP-002 LOR-"Off"	Depress Local Start	a. Pump does not start b. Off indic at DCS c. No Remote indic at DCS		
3	09-PMP-001 LOR-"Off"	Depress MCC Start	a. Pump does not start b. Off indic at DCS c. No Remote indic at DCS		
4	09-PMP-002 LOR-"Off"	Depress MCC Start	a. Pump does not start b. Off indic at DCS c. No Remote indic at DCS		
5	09-PMP-001 LOR-"Off" DCS Auto/Man-"Manual"	Depress DCS Start	a. Pump does not start b. Off indic at DCS c. No Remote indic at DCS		
6	09-PMP-002 LOR-"Off" DCS Auto/Man-"Manual"	Depress DCS Start	a. Pump does not start b. Off indic at DCS c. No Remote indic at DCS		
7	09-PMP-001 LOR-"Off" DCS Auto/Man-"Automatic" Select 09-PMP-001 as "Duty"	Reduce 3W system pressure below start pressure	a. Pump does not start b. Off indic at DCS c. No Remote indic at DCS d. Duty indic at DCS		
8	09-PMP-002 LOR-"Off"	Reduce 3W system pressure	a. Pump does not start		
	DCS Auto/Man-"Automatic"	below start pressure	b. Off indic at DCS		
	Select 09-PMP-002 as "Duty"		c. No Remote indic at DCS		
			d. Duty indic at DCS		
9	09-PMP-001 LOR- "Local" Depress local LOS	Depress Local Start	a. Pump does not start b. Off indic at DCS c. No Remote indic at DCS		
10	09-PMP-002 LOR- "Local" Depress local LOS	Depress Local Start	a. Pump does not start b. Off indic at DCS c. No Remote indic at DCS		
11	09-PMP-001 LOR- "Local" Depress local LOS	Depress MCC Start	a. Pump does not start b. Off indic at DCS		

PROCESS SYSTEM: Plant 3 Water

P&ID: P1000-1
SCHEM DIAG NO.: 900

EQUIPMENT: 09-PMP-001 3W Pump No.1
09-PMP-002 3W Pump No.2
PIT-9-3

Testing Step	Mode Set-up	Operational Test	Required Result	Initial Complete Kr	CM
			c. No Remote indic at DCS		
12	09-PMP-002 LOR- "Local" Depress local LOS	Depress MCC Start	a. Pump does not start b. Off indic at DCS c. No Remote indic at DCS		
13	09-PMP-001 LOR- "Local" Depress local LOS	Depress DCS Start	a. Pump does not start b. Off indic at DCS c. No Remote indic at DCS		
14	09-PMP-002 LOR- "Local" Depress local LOS	Depress DCS Start	a. Pump does not start b. Off indic at DCS c. No Remote indic at DCS		
15	09-PMP-001 LOR- "Remote" Depress local LOS DCS Auto/Man-"Manual"	Depress DCS Start	a. Pump does not start b. Off indic at DCS c. Remote indic at DCS		
16	09-PMP-002 LOR- "Remote"	Depress DCS Start	a. Pump does not start		
	Depress local LOS DCS Auto/Man-"Manual"		b. Off indic at DCS c. Remote indic at DCS		
17	09-PMP-001 LOR- "Remote" Depress local LOS DCS Auto/Man-"Automatic" Select 09-PMP-001 as "Duty"	Reduce 3W system pressure below start pressure	a. Pump does not start b. Off indic at DCS c. Remote indic at DCS d. Duty indic at DCS		
18	09-PMP-002 LOR- "Remote" Depress local LOS DCS Auto/Man-"Automatic" Select 09-PMP-002 as "Duty"	Reduce 3W system pressure below start pressure	a. Pump does not start b. Off indic at DCS c. Remote indic at DCS d. Duty indic at DCS		
19	09-PMP-001 LOR- "Local"	Depress Local Start	a. Pump starts b. On indic at DCS		
20	09-PMP-002 LOR- "Local"	Depress Local Start	a. Pump does not start		
21	09-PMP-001 LOR- "Local"	Depress Local Stop	a. Pump stops		
22	09-PMP-002 LOR- "Local"	Depress Local Start	a. Pump starts b. On indic at DCS		
23	09-PMP-001 LOR- "Local"	Depress Local Start	a. Pump does not start		

PROCESS SYSTEM: Plant 3 Water

P&ID: P1000-1
SCHEM DIAG NO.: 900

EQUIPMENT: 09-PMP-001 3W Pump No.1
09-PMP-002 3W Pump No.2
PIT-9-3

Testing Step	Mode Set-up	Operational Test	Required Result	Initial Complete Kr	CM
24	09-PMP-002 LOR- "Local"	Depress Local Stop	a. Pump stops		
25	09-PMP-001 LOR- "Local"	Depress MCC Start	a. Pump starts		
26	09-PMP-001 LOR- "Local"	Depress MCC Stop	a. Pump stops		
27	09-PMP-002 LOR- "Local"	Depress MCC Start	a. Pump starts		
28	09-PMP-002 LOR- "Local"	Depress MCC Stop	a. Pump stops		
29	09-PMP-001 LOR- "Local"	Depress DCS Start	a. Pump does not start		
30	09-PMP-002 LOR- "Local"	Depress DCS Start	a. Pump does not start		
31	09-PMP-001 LOR- "Remote" DCS Auto/Man- "Manual"	Depress Local Start Depress MCC Start	a. Pump does not start		
32	09-PMP-002 LOR- "Remote" DCS Auto/Man- "Manual"	Depress Local Start Depress MCC Start	a. Pump does not start		
33	09-PMP-001 LOR- "Remote" DCS Auto/Man- "Manual"	Depress DCS Start	a. Pump starts		
34	09-PMP-001 LOR- "Remote" DCS Auto/Man- "Manual"	Depress DCS Stop	a. Pump stops		
35	09-PMP-002 LOR- "Remote" DCS Auto/Man- "Manual"	Depress DCS Start	a. Pump starts		
36	09-PMP-002 LOR- "Remote" DCS Auto/Man- "Manual"	Depress DCS Stop	a. Pump stops		
37	09-PMP-001 LOR- "Remote" DCS Auto/Man- "Manual" Depress DCS Start	Depress Local Stop	a. Pump stops		
38	09-PMP-001 LOR- "Remote" DCS Auto/Man- "Manual" Depress DCS Start	Depress MCC Stop	a. Pump stops		
39	09-PMP-002 LOR- "Remote" DCS Auto/Man- "Manual" Depress DCS Start	Depress Local Stop	a. Pump stops		

PROCESS SYSTEM: Plant 3 Water

P&ID: P1000-1
SCHEM DIAG NO.: 900

EQUIPMENT: 09-PMP-001 3W Pump No.1
09-PMP-002 3W Pump No.2
PIT-9-3

Testing Step	Mode Set-up	Operational Test	Required Result	Initial Complete Kr	CM
40	09-PMP-002 LOR- "Remote" DCS Auto/Man- "Manual" Depress DCS Start	Depress MCC Stop	a. Pump stops		
41	09-PMP-001 LOR- "Remote" DCS Auto/Man- "Automatic" Select 09-PMP-001 as "Duty"	Reduce 3W system pressure below start pressure	a. Pump starts automatically at start PSI		
42	09-PMP-001 LOR- "Remote" DCS Auto/Man- "Automatic" Select 09-PMP-001 as "Duty"	Depress Local Stop	a. Pump stops		
43	09-PMP-002 LOR- "Remote" DCS Auto/Man- "Automatic" Select 09-PMP-002 as "Duty"	Reduce 3W system pressure below start pressure	a. Pump starts automatically at start PSI		
44	09-PMP-002 LOR- "Remote"	Depress Local Stop	a. Pump stops		
	DCS Auto/Man- "Automatic" Select 09-PMP-002 as "Duty"				
45	09-PMP-001 LOR- "Remote" DCS Auto/Man- "Automatic" Select 09-PMP-001 as "Duty"	With pump running, activate low water level alarm	a. Pump stops b. Cannot start either pump until low water alarm clears c. Low Lvl alarm at DCS		
46	09-PMP-002 LOR- "Remote" DCS Auto/Man- "Automatic" Select 09-PMP-002 as "Duty"	With pump running, activate low water level alarm	a. Pump stops b. Cannot start either pump until low water alarm clears c. Low Lvl alarm at DCS		
47	09-PMP-001 LOR- "Remote" DCS Auto/Man- "Automatic" Select 09-PMP-001 as "Duty"	With pump running, activate high pressure alarm	a. Pump stops b. Cannot start pump until alm clears and Rst is pushed c. High Press alarm at DCS		

PROCESS SYSTEM: Plant 3 Water

P&ID: P1000-1
SCHEM DIAG NO.: 900

EQUIPMENT: 09-PMP-001 3W Pump No.1
09-PMP-002 3W Pump No.2
PIT-9-3

Testing Step	Mode Set-up	Operational Test	Required Result	Initial Complete Kr	CM
48	09-PMP-002 LOR- "Remote" DCS Auto/Man- "Automatic"	With pump running, activate high pressure alarm	a. Pump stops b. Cannot start pump until		
	Select 09-PMP-002 as "Duty"		alm clears and Rst is pushed		
			c. High Press alarm at DCS		
49	09-PMP-001 LOR- "Remote" DCS Auto/Man- "Automatic" Select 09-PMP-001 as "Duty"	With pump running, activate low pressure alarm	a. Pump continues running b. Low Press alarm at DCS		
50	09-PMP-002 LOR- "Remote" DCS Auto/Man- "Automatic" Select 09-PMP-002 as "Duty"	With pump running, activate low pressure alarm	a. Pump continues running b. Low Press alarm at DCS		
51	Both pumps in "Remote" Both pumps in "Automatic" Select 09-PMP-001 as "Duty"	With 09-PMP-001 running, open MCC breaker	a. 09-PMP-002 automatically starts b. 09-PMP-001 "Off" indic at DCS		
52	-----	-----	Verify local PIT and DCS pressure readings match		

All Operational Tests Successfully Completed:

Contractor's Initials: _ Date: _____

Engineer's Initials: _ Date: _____

END OF SECTION

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SECTION 01730 - OPERATION AND MAINTENANCE DATA

PART 1 OPERATION AND MAINTENANCE MANUALS

1.1 PRELIMINARY MANUALS

Prior to the delivery and installation of any item of machinery or equipment the Contractor shall submit a preliminary Operation and Maintenance Manual and the Equipment Summary Form. The preliminary manuals will be reviewed by the Construction Manager for general content, and the Construction Manager will advise the Contractor within five days of receipt if the manual is acceptable in general content for the delivery and installation of the equipment or machinery. The preliminary manuals must at a minimum include the detailed manufacturer's requirements for storage and installation of the equipment. No equipment or machinery shall be delivered or installed if the general content and storage and installation instructions of the manual are found to be deficient.

1.2 OPERATION AND MAINTENANCE MANUAL SUBMITTAL

The final Operation and Maintenance Manuals must be submitted and favorably reviewed prior to the initiation of the Process Testing which includes the machinery or equipment. Three (3) copies of each favorably reviewed Operation and Maintenance Manual shall be provided.

All manuals shall be bound in a 3-ring binder with rigid covers, marked to indicate the specific equipment furnished for this project, and shall utilize tab sheets to organize the information. Operation and maintenance manuals shall include:

A. Cover Page: Equipment Name, equipment tag number, project name, Owner's name, and other data as appropriate.

B. Laminated Table of Contents: General description of information provided within each tab section.

C. Equipment Summary Form: Completed form in the format attached below. Insert Equipment Summary Form after the tab sheet of each equipment section. The manufacturer's standard form will not be acceptable. Manuals submitted without equipment summary form fully completed, including equipment identification number, will be rejected and returned.

D. The manufacturer warrantee certificate.

E. Lubrication Information: Required lubricants and lubrication schedules.

F. Control Diagrams: Internal and connection wiring, including logic diagrams, wiring diagrams for control panels, ladder logic for computer based systems, and connections between existing systems and new additions, and adjustments such as calibrations and set points for relays, and control or alarm contact settings.

G. Start-up Procedures: Recommendations for installation, adjustment, calibration, and troubleshooting.

H. Operating Procedures:

1. Step-by-step procedures for starting, operating, and stopping equipment under specified modes of operation.

2. Include safety precautions and emergency operating shutdown instructions.

I. Preventative Maintenance Procedures: Recommended steps and schedules for maintaining equipment.

J. Overhaul Instructions: Directions for disassembly, inspection, repair and reassemble of the equipment; safety precautions; and recommended tolerances, critical bolt torques, and special tools that are required.

K. Parts List: Generic title and identification number of each component part of equipment; include bearing manufacturer, model and ball or roller pass frequencies for every bearing.

L. Spare Parts List: Recommended number of parts to be stored at the site and special storage precautions.

M. Drawings: Exploded view or plan and section views with detailed callouts.

N. Provide electrical and instrumentation schematic record drawings.

O. Source (Factory) Quality Control Test Results: Provide copies of factory test reports as specified in the Technical Specifications.

P. Field Quality Control Test Results: After field testing is completed, insert field test reports as specified in the Technical Specifications.

1.3 ELECTRONIC COPY

All manuals shall be provided in an electronic format which entails all information included by the contractor in the three ring binders. This will include providing the following electronic format documents:

- All text portions of the Operations and Maintenance Manual specifically tailored for this project shall be provided in HTML format.

- All graphical portions of the Operations and Maintenance Manual specifically tailored for this project shall be provided in GIF (schematics, line drawings, etc.) of JPEG (photos, etc.) format.

- All shop drawings shall be provided in AutoCAD format – latest release at time of O&M preparation.

- All forms that may be required for maintenance shall be provided in MS Word format.

- All other documents including, but not limited to, brochures that need to be scanned that are specifically tailored for this project shall be provided in a searchable PDF format.

Equipment Summary Form

1. Equipment Item: _____

   Is it a packaged unit, i.e. pump, motor, shaft? Yes __ No _____

   If yes, please detail. _____

   _____

   _____

2. How many: _____
3. Cost: _____
4. Manufacturer: _____

   Address: _____

   Phone #: _____ Fax: _____

   Email: _____ Website: _____
5. Equipment Identification Numbers:

   Serial Number: _____

   Model: _____

   Part #: _____

   Equipment ID No. _____
6. Location of Equipment:
7. Weight of Individual Components (Over 100 Pounds): _____

   _____
8. Nameplate Data:

   Horsepower: _____ RPM: _____

   Amperage: _____ Size: _____

   Voltage: _____ Frame Size: _____

   Service Factor (S.F.): _____ Seal Size: _____

   Speed: _____ Seal Type: _____

   Enclosure Type: _____ Bearings: _____

   GPM: _____ Impeller Size: _____

   Maximum Capacity @ _____ ft TDH Other: _____

   Design Point Capacity @ _____ ft TDH
9. Manufacturer's Local Representative:

   Name: _____

   Address: _____

   Telephone Number: _____

   Email: _____ Website: _____

10. Maintenance Requirements (including schedules):

TASK	SCHEDULE

11. Lubricant List:

12. Spare Parts (with accurate part #'s):

13. Comments: _____

_____

14. General Info:

Year Installed: _____

Expected Life: _____

Project Name & Number: _____

Design Engineer: _____

15. Warranty:

Start Date: _____

Expiration Date: _____

Prorated: _____

END OF SECTION

SECTION 01750 - SPARE PARTS AND MAINTENANCE MATERIALS

1.0 RESPONSIBILITY FOR SPARE PARTS AND TOOLS

Where equipment, special repair tools, safety equipment, or other loose parts are specified to be furnished, they shall be stored by the Contractor until permanent building storage areas are complete, secure, and lockable.

The Contractor shall inventory such parts and transmit the inventory, using the form appended to this section, the Construction Manager at an agreed upon time. All spare parts and tools shall be labeled and neatly packed into boxes with contents of each box label and secured to the box. Any items over 50 lbs shall be in wooden crates with hinged and lockable lids, placed on pallets and delivered to the City at a location to be defined.

All safety related items shall be provided prior to testing. Specified spare parts shall be transferred for related equipment prior to the use or occupancy of equipment as provided in Articles 11.3 and 11.4 of the General Conditions.

END OF SECTION

City of Brentwood

Wastewater Treatment Plant Expansion – Phase II

Project No.592-59140

Transfer of Spare Parts – Section 01750

No. _____

Equipment: _____

Manufacturer: _____

Specification Section: _____

Spare Parts

Item	Quantity	Description	Part #

Reviewed by Construction Manager: _____ Date: _____

Transferred by Contractor: _____ Date:_____

Accepted by City of Brentwood: _____ Date:_____

*****END OF SECTION *****

SECTION 02050 – DEMOLITION AND RECONSTRUCTION

PART 1 GENERAL

1.1 THE REQUIREMENT

A. The Contractor shall furnish all materials, supplies, tools, equipment, and labor as required for the reconstruction of all or portions of existing civil, landscaping, structural, architectural, mechanical, HVAC, electrical, and instrumentation facilities as specified herein and/or shown on the Drawings.

B. Reconstruction shall include, but shall not be limited to, the following items:

1. Demolition
2. Salvage
3. Relocation
4. Abandonment
5. Removal
6. Rehabilitation
7. Disposal

C. Related Work Specified Elsewhere

1. Section 01010 - Summary of Work
2. Section 01340 - Shop Drawings, Product Data and Samples
3. Section 02200 - Earthwork
4. Section 03922 - Modifications and Repair to Concrete
5. Section 09900 – Painting and Coating

D. The Contractor shall carefully coordinate the reconstruction in areas where existing facilities are interconnected with new facilities and where existing facilities shall remain operational. The reconstruction specified and shown in the Contract Documents is not all inclusive and the Contractor shall be responsible to perform the reconstruction specified, shown, or which can be reasonably inferred from the Contact Documents as necessary to complete the Project. The Specifications and Drawings identify the major facilities that shall be reconstructed, but auxiliary utilities such as water, air, chemicals, drainage, lubrication, fluid power, electrical wiring, controls, and instrumentation are not necessarily shown. The Contractor shall comply with Project and operational sequencing requirements specified in Section 01010 - Summary of Work.

E. The Contractor shall note that the Drawings used in this Contract to indicate reconstruction are based on design drawings for the existing facilities. The plans and sections depicted in the Contract Documents have been reproduced to show existing conditions and to clarify the scope of work as much as possible. Prior to bidding, the Contractor shall conduct a comprehensive survey at the Project Site of the facilities to verify the correctness and exactness of the Drawings, the scope of work, and the extent of auxiliary utilities. A set of design drawings is available for review at the Project site.

F. While reconstruction is being performed, the Contractor shall provide adequate access for the continued operation and maintenance of equipment and treatment processes. The Contractor shall erect and maintain fences, warning signs, barricades, and other devices as required for the protection of the Contractor's employees and the Owner's personnel at the plant. The Contractor shall remove all such protection when reconstruction activities are complete, or as work progresses, or when directed by the Engineer.

1.2 CONTRACTOR SUBMITTALS

A. Reconstruction activities and procedures, including operation sequence, shall be submitted to the Engineer for approval. The procedures shall provide for safe conduct of the Work, careful removal and disposition of materials and equipment, protection of existing facilities that are to remain undisturbed, coordination with existing facilities to remain in service, and timely disconnection of utility service. The storage plan for all salvaged items shall be included. The procedures shall include a detailed description and time schedule of the methods and equipment to be used for each operation and the sequence of operation. Submittals shall be in accordance with Section 01340 - Shop Drawings, Product Data and Samples.

PART 2 PRODUCTS

2.1 GENERAL

A. Demolition: Existing pavement, structures, equipment, piping, valves, ductwork, electrical gear, instrumentation, utilities, and related appurtenances such as anchors, supports, and hardware shown or required to be demolished as part of the Work shall be removed and disposed of by the Contractor unless otherwise indicated. Removal of buried structures, utilities, and appurtenances includes the related excavation and backfill as required. Items to be removed shall be disposed of offsite by the Contractor as part of the Work.

B. Salvage: Items of existing equipment, piping, valves, electrical gear, instrumentation, utilities, and appurtenances shown to be salvaged shall be removed by the Contractor. Materials and equipment to be salvaged shall be removed in a manner that maintains them in a condition equivalent to their condition prior to being removed. Salvaged items shall be stockpiled and protected on the jobsite by the Contractor at a location directed by the Owner. The Contractor shall be responsible to properly safeguard the salvaged items against damage and loss during removal and handling. The Contractor shall coordinate with the Owner during construction with regard to equipment to be salvaged and shall turn over to the Owner and deliver to a location at the WWTP site as directed by the Owner upon removal. Contractor shall provide Owner with a minimum of 5 working days advance notice prior to salvage.

C. Relocation: Items of existing equipment, piping, valves, electrical gear, instrumentation, utilities, and appurtenances shown to be relocated shall be removed and reinstalled by the Contractor. Materials and equipment to be relocated shall be removed in a manner that maintains them in a condition equivalent to their condition prior to being removed. The Contractor shall be responsible to properly safeguard the relocated items against damage and loss during removal, handling, storage, and installation in the new location.

D. Abandonment: Items of existing equipment, piping, valves, electrical gear, instrumentation, utilities, and appurtenances shown to be abandoned in place shall be protected from damage as specified herein and shown on the Drawings. Pipelines that are to be cut and abandoned in place shall be capped unless otherwise indicated.

E. Remove: “Remove” shall be defined as “Demolition” and “Disposal” by the Contractor unless otherwise noted.

F. Rehabilitation

1. Existing civil, landscaping, structural, architectural, mechanical, HVAC, electrical, and instrumentation work disturbed or damaged by reconstruction activities shall be repaired and rehabilitated as specified herein and shown on the Drawings at the Contractor’s expense.

2. Damaged items shall be repaired or replaced with new materials as required to restore damaged items of surfaces to a condition equal to and matching that existing prior to damage or start of work of this Contract.

3. In buildings with reconstruction work, the Contractor shall not use any Owner equipment (e.g., bridge cranes and monorails) unless authorized in advance in writing by the Engineer. Such authorization shall be subject to documentation by the Contractor of the loading he proposes to place on the equipment and subject to Owner requirements for crane use for operating and maintenance needs. Any damage sustained in the use of a crane by the Contractor shall be repaired or replaced at no cost to the Owner. The damaged unit shall be repaired or replaced as described above.

G. Disposal: The Contractor shall be responsible for the offsite disposal of all debris resulting from reconstruction in compliance with all local, state, and federal codes and requirements. Debris resulting from reconstruction includes, but is not limited to, all concrete masonry, metals, asphalt, equipment, liquids that are required to be drained, solids that require removal, sludge/grease/grit associated with existing pipes or manholes to be removed, wires, cables, conduits, and miscellaneous material resulting from demolition, salvage, relocation, abandonment, and rehabilitation activities and procedures.

PART 3 EXECUTION

3.1 GENERAL

A. The Contractor shall be responsible for the coordination of reconstruction work with the Owner and Engineer. Unless otherwise specified or shown, the Contractor shall be responsible for the sequence of reconstruction activities. All reconstruction shall be performed in accordance with applicable safety rules and regulations.

B. The Contractor shall insure that any utilities connected to structures, equipment, and facilities to be removed, relocated, salvaged, replaced, or abandoned shall be inoperable, replaced with new utilities, or adequately bypassed with temporary utilities before proceeding with reconstruction.

C. The Contractor shall take precautions to avoid damage to adjacent facilities and to limit the reconstruction activities to the extent specified and shown. If reconstruction beyond the scope specified or shown is required, the Contractor shall obtain written approval from the Engineer prior to commencing work.

D. Explosives shall not be permitted for demolition.

3.2 INSTALLATION

A. Protection of Existing Facilities

1. Before beginning any reconstruction work, the Contractor shall carefully survey the existing facilities and examine the Specifications and Drawings to determine the extent of reconstruction and coordination with the Work. Existing facilities not subject to reconstruction shall be protected and maintained. Damage to existing facilities shall be repaired or replaced to its existing condition at no additional cost to the Owner.

2. Contractor shall ensure the safe passage of persons around area of demolition.

3. The Contractor shall insure that structural elements are not overloaded and shall be responsible for shoring, bracing, or adding new supports as may be required to insure adequate structural support as a result of any reconstruction work performed under any part of this Contract. The Contractor shall remove all temporary protection when the Work is complete or when so authorized by the Engineer.

4. The Contractor shall carefully consider all bearing loads and capacities for placement of equipment and material on Site. In the event of any questions as to whether an area to be loaded has adequate bearing capacity, the Contractor shall consult with the Engineer prior to the placement of such equipment of material.

B. Demolition, Salvage, Relocation

1. The Contract drawings identify existing facilities to be demolished, salvaged, and/or relocated. Auxiliary utility services such as water, air, chemicals, drainage, lubrication, fluid power, electrical wiring, controls, and instrumentation are not necessarily indicated or shown. The Contractor shall verify the scope of the work to remove the equipment indicated; coordinate its shutdown, removal, replacement, or relocation; and submit an outage plan in accordance with Section 01340 - Shop Drawings, Product Data and Samples. The removal of existing facilities for demolition, salvage, and relocation shall include, but not be limited to, the following requirements at no addition cost to the Owner:

a. All equipment supports, including concrete pads, baseplates, mounting bolts, and support hangers, shall be removed. Any damage to the existing structure shall be repaired as specified.

b. All exposed piping (including vents and drains) and valves shall be removed. Where exposed piping penetrates existing floors and walls, the piping, including wall thimbles, shall be removed to a minimum depth of 2 inches. All resulting openings in the structure shall be repaired as specified herein.
c. All electrical control panels, junction boxes, motor control centers, and local switches and pushbuttons shall be removed.
d. All exposed electrical conduits and associated wiring shall be removed. All resulting openings in structures shall be repaired as specified herein.
e. Connections to embedded electrical conduits shall be removed a minimum of 2 inches from the finished surface of the existing structure. All wiring shall be removed and the resulting openings shall be repaired as specified herein.
f. All associated instrumentation devices shall be removed.
g. All auxiliary utility support systems shall be removed.
h. The area shall be thoroughly cleaned such that little or no evidence of the previous equipment installation will remain.

2. Asphalt and concrete pavement, curbs and gutters shall be removed as necessary to perform construction. The limits of removal shall be saw cut in neat clean lines. When the required improvements have been constructed, new asphalt and concrete pavement, curbs, and gutters shall be replaced to match the original unless otherwise specified or shown.

3. Footings, foundation walls, below-grade construction and concrete slabs on grade shall be demolished and removed to a depth that will not interfere with new construction, but not less than 36 inches below existing ground surface or future ground surface, whichever is lower, unless otherwise stated in this Section or shown on the Drawings.

4. Below-grade areas and voids resulting from demolition of pipes and structures shall be completely filled. All fill and compaction shall be in accordance with Section 02200 – Earthwork. After fill and compaction, surfaces shall be graded to meet adjacent contours and to provide flow to surface drainage structures, or as shown.

5. When existing pipe is cut or removed, the Contractor shall plug or cap all resulting open ends whether or not shown. Where remaining piping is exposed, the remaining piping shall be blind-flanged or fitted with a removable cap or plug. If the existing piping is to remain in service, all blind flanges, plugs, and/or caps shall be gasketed where applicable and leak tight for the existing pipes service conditions. The Contractor shall use fittings that are specifically designed for the existing pipe. Contractor shall provide thrust protection as required.

6. When existing piping is removed from existing structures, the Contractor shall fill in resulting openings in the structures and repair any damage such that the finished rehabilitated structure shall appear as a new homogeneous unit with little or no indication of where the new and old materials join. The openings in water-bearing structures shall be filled with non-shrink grout to be watertight and reinforced as required or shown to prevent leakage from the structure for the service conditions of the structure. In all locations where the surface of the grout will be exposed to view, the non-shrink grout shall be recessed to approximately

1/2-inch from the exposed surface and the recessed area filled with cement mortar grout.

7. When concrete walls are removed from existing structures, the Contractor shall fill in resulting openings in the structures and repair any damage such that the finished rehabilitated structure shall appear as a new homogeneous unit with little or no indication of where the new and old materials join. The openings in water-bearing structures shall be filled with non-shrink grout to be watertight and reinforced as required or shown to prevent leakage from the structure for the service conditions of the structure. In all locations where the surface of the grout will be exposed to view, the non-shrink grout shall be recessed to approximately 1/2-inch from the exposed surface and the recessed area filled with cement mortar grout.

8. All electrical reconstruction shall be conducted by the Contractor in a safe and proper manner at all times to avoid injury from electrical shock to the Owner's and Contractor's personnel. Prior to electrical reconstruction, the Contractor shall notify the Owner in writing a minimum of 5 days prior to requested deenergization. The Owner shall deenergize and safe-out the equipment. At a minimum the Contractor shall follow OSHA lock-out/tag-out guidelines, National Electrical Safety Code, and the Owner's own lock-out/tag-out procedures when doing work in the plant. Contractors shall follow established safety procedures prepared at the start of the job.

9. The Contractor shall perform a functional test of existing equipment that is relocated and reinstalled to ensure the equipment functions in the manner documented during initial inspection. The Contractor shall inform the Engineer in writing a minimum of 5 days prior to the functional testing in order for the Owner and Engineer to witness the test. If, in the opinion of the Engineer, the relocated equipment does not function in a satisfactory manner, the Contractor shall make repairs and modifications necessary to restore the equipment to its operating condition immediate prior to relocation at no expense to the Owner.

C. Abandonment

1. Existing facilities to be abandoned shall be prepared as specified herein or shown on the Drawings. Where existing buried piping is to be abandoned, the Contractor shall remove the abandoned pipe for a distance of 5 feet from any connecting structures unless otherwise noted on the drawings. All openings at the existing structures shall be repaired. The remaining pipe shall be capped at both ends prior to backfill. Buried piping, 12-inch diameter or greater, shall be completely sand-filled prior to closure of the piping ends.

D. Rehabilitation

1. Certain areas of existing roads, structures, piping, conduits, and the like will be affected by work necessary to complete modifications under this Contract. The Contractor shall be responsible to rehabilitate those areas affected by the construction activities.

2. Where new rectangular openings are to be installed in concrete or concrete masonry walls or floors, the Contractor shall score the edges of each opening (both sides of wall or floor slab) by saw cutting clean straight lines to a minimum

depth of 1 inch and then chipping out the concrete. Alternately, the sides of the opening (not the corners) can be formed by saw cutting completely through the slab or wall. Saw cuts deeper than 1 inch (or the depth of cover over existing reinforcing steel, whichever is less) shall not be allowed to extend beyond the limits of the opening. Corners shall be made square and true by a combination of core drilling and chipping or grinding. All necessary precautions shall be taken during removal of concrete to prevent debris from falling into or entering adjacent tanks in service or from damaging adjacent equipment or piping. Saw cuts allowed to extend beyond the opening shall be repaired by filling with non-shrink grout. The concrete around any exposed reinforcement steel shall be chipped back and exposed reinforcement steel cut a minimum of 2 inches from the finished face of the new opening and painted with epoxy paint. The inside face of the new opening shall be grouted with an epoxy cement grout to fill any voids and cover the exposed aggregate and shall be trowel-finished to provide a plumb and square opening.

3. When new piping is installed in existing structures, the Contractor shall accurately position core-drilled openings in the concrete as shown or otherwise required. Openings shall be of sufficient size to permit a final alignment of pipelines and fittings without defection of any part and to allow adequate space for satisfactory packing where pipe passes through the wall to ensure watertightness around openings so formed. The cores shall be provided with continuous keyways to hold the filling material in place, and they shall have a slight flare to facilitate grouting and the escape of entrained air during grouting. Before placing the non-shrink grout, concrete surfaces shall be sandblasted, thoroughly cleaned of sand and any other foreign matter, and coated with epoxy bonding compound.

    a. The pipes, castings, or conduits, as specified, shall be grouted in place by pouring in grout under a head of at least 4 inches. The grout shall be poured or rammed or vibrated into place to fill completely the space between the pipes, castings, or conduits and the sides of the openings so as to obtain the same watertightness as through the wall itself. The grouting casings shall then be water cured.
    b. In all locations where the surface of the grout will be exposed to view, the non-shrink grout shall be recessed to 1/2-inch back of the exposed surface and the recessed area filled with cement mortar grout.

4. When new piping is to be connected to existing piping, the existing piping shall be cut square and ends properly prepared for the connection shown. Any damage to the lining and coating of the existing piping shall be repaired by the Contractor. Dielectric insulating joints shall be installed at interconnections between new and existing piping.

5. Where existing equipment, equipment pads and bases, piping, piping supports, electrical panels and devices, conduits, and associated appurtenances are removed, the Contractor shall rehabilitate the affected area such that little or no evidence of the previous installation remains. Openings in concrete floors, walls, and ceilings from piping, conduit, and fastener penetrations shall be filled with non-shrink grout and finished to match the adjacent area. Concrete pads and bases for equipment and supports shall be removed by chipping away concrete and cutting any exposed reinforced steel and anchor bolts a minimum of 2 inches below finished grade and painted with epoxy paint. The area of concrete to be rehabilitated shall be scored by saw cutting clean, straight lines to a minimum

depth of 1-1/2-inches (or the depth of cover over reinforcing steel, whichever is less). The area within the scored lines shall be patched with non-shrink grout to match the adjacent grade and finish. Abandoned connections to piping and conduits shall be terminated with blind flanges, caps, and plugs suited for the material, type, and service of the pipe or conduit.

6. Where concrete walls are removed, the Contractor shall rehabilitate the affected area such that little or no evidence of the previous installation remains. Openings in concrete floors and walls shall be filled with non-shrink grout and finished to match the adjacent area. Concrete shall be removed by chipping away concrete and cutting any exposed reinforced steel and anchor bolts a minimum of 2 inches below finished grade and painted with epoxy paint. The area of concrete to be rehabilitated shall be scored by saw cutting clean, straight lines to a minimum depth of 1-1/2-inches (or the depth of cover over reinforcing steel, whichever is less). The area within the scored lines shall be patched with non-shrink grout to match the adjacent grade and finish.

7. Existing reinforcement to remain in place shall be protected, cleaned, and extended into new concrete.

    a. Where new concrete joins existing concrete at the removal line, reinforcement shall be cut-off flush with the concrete surface at the removal line.
    b. Where the concrete surface at the removal line is the finished surface, the reinforcement shall be cut back 2 inches below the finished concrete surface, the ends painted with epoxy paint and the remaining holes patched with a cement mortar grout.

8. Where existing handrailing is removed, post embedments and anchors shall be removed entirely with no metal remaining (cutting posts at surface is not acceptable) and post holes shall be filled with non-shrink grout flush to the floor surface. At the point of continuation of existing handrailing, a new post with rail connections matching the existing handrailing system shall be installed. New posts in existing concrete floors shall be installed in core-drilled socket holes and the annular space between the post and hole filled with non-shrink grout.

9. Where reconstruction activities damage the painting and coating of adjacent or nearby facilities, the damaged areas shall be surface prepared and coated to match the original painting and coating with a compatible system in accordance with Section 09900 – Painting and Coating. Equipment items that are relocated shall be completely surface prepared and coated in accordance with Section 09900 – Painting and Coating.

10. The Drawings identify the major equipment and structures to be demolished. Auxiliary systems such as water, auxiliary equipment, drainage, electrical wiring, controls, and instrumentation are not necessarily shown. In association with the electrical equipment demolition, the following work shall also be performed at no additional cost to the Owner.

    a. All auxiliary utility support systems to facilitate proper operation of the plant shall remain in service except when auxiliary systems are identified for demolition in which case the systems may be decommissioned in accordance with sequencing and constraints in Section 01010. Auxiliary

utility support systems include but are not limited to water, ventilation, lighting, and sump pumping. Temporary provisions may be made to maintain such systems during switchover.

b. During construction, electrical systems shall be maintained as required to support auxiliary utility support systems. These systems can and will be a combination of existing, temporary, and new items. All demolition work shall be performed in a manner and sequence to ensure continued operation of these auxiliary systems.

c. The area shall be thoroughly cleaned such that little or no evidence of the previous equipment installation will remain.

11. Where existing materials and equipment are removed or relocated, remove all materials no longer used such as studs, straps, conduits, and wires. Remove or cut off concealed or embedded conduit, boxes, or other materials and equipment to a point at least 2 inch below the final finished surface.

E. Remove: “Remove” shall be conducted as described under “Demolition” and “Disposal” by the Contractor unless otherwise noted.

F. Disposal

1. Demolition and removal of debris shall be conducted to ensure minimum interference with roads, streets, walks, and other adjacent occupied or used facilities which shall not be closed or obstructed without permission from the Owner. Alternate routes shall be provided around closed or obstructed traffic ways.

2. Site debris, rubbish, and other materials resulting from reconstruction operations shall be legally removed and disposed of at the Contractor’s expense. Structures and equipment to be demolished shall be cleaned prior to demolition and the wash water properly disposed of. No trace of these structures shall remain prior to placing of backfill in the areas from which structures were removed.

3. The use of burning at the project site for the disposal of refuse, debris, and waste materials resulting from demolition and site clearing operations will not be permitted.

G. Occupancy and Pollution Control

1. Water sprinkling, temporary enclosures, chutes, and other suitable methods shall be used to limit dust and dirt rising and scattering in the area. Comply with all government regulations and Contract Documents requirements pertaining to environmental protection.

2. Water shall not be used when it creates hazardous or objectionable conditions such as ice, flooding, or pollution.

H. Cleaning

1. During and upon completion of work, the Contractor shall promptly remove unused tools and equipment, surplus materials, rubbish, debris, and dust and shall leave areas affected by work in a clean, approved condition.

2. Adjacent structures shall be cleaned of dust, dirt, and debris caused by reconstruction, as directed by the Engineer or governing authorities, and adjacent areas returned to condition existing prior to start of work.

3. The Contractor shall clean and sweep the street and road in accordance with Division 1.

END OF SECTION

SECTION 02100 - SITE PREPARATION, GENERAL

PART 1 GENERAL

1.1 THE REQUIREMENT

A. The work of this Section includes all those measures required during the Contractor's initial move onto the site to protect existing fences, structures and associated improvements, streets, and utilities downslope of construction areas from damage due to boulders, trees or other objects dislodged during the construction process; clearing, grubbing and stripping; and regrading of certain areas to receive embankment fill.

1.2 SITE INSPECTION

A. Prior to moving onto the project site, the Contractor shall visit and inspect the site conditions and review maps of the existing plant site and facilities delineating the Owner's property and right-of-way lines.

PART 2 PRODUCTS – NOT USED

PART 3 EXECUTION

3.1 PRIMARY PLANT SITE ACCESS

A. The Contractor shall use the existing plant access road east of the existing detention basin for access to the work area. Contractor shall be responsible for any necessary upgrades to the access road to accommodate the work at the site. Prior to completion of construction, Contractor shall be responsible for repairing, resurfacing, or reconstructing of all roads that were used to complete work at the site as defined by the Contract Drawings.

B. Utility Interference: Where existing utilities interfere with the Work of this Section, the Work shall be stopped and the Engineer notified of interferences before proceeding in accordance with the Contract Documents.

3.2 CLEARING, GRUBBING, AND STRIPPING

A. All construction areas not previously cleared or grubbed shall be cleared of grass and weeds to at least a depth of six inches and cleared of structures, concrete or masonry debris, trees, logs, upturned stumps, loose boulders, and any other objectionable material of any kind which would interfere with the performance or completion of the Work, create a hazard to safety, or impair the Work's subsequent usefulness or obstruct its operation. Loose boulders within 10 feet of the top of cut lines shall be incorporated in landscaping or removed from the site. Trees and other natural vegetation outside the actual lines of construction shall be protected from damage during construction, as directed by the Engineer.

B. Within the limits of clearing, the areas below the natural ground surface shall be grubbed to a depth necessary to remove all stumps, roots, buried logs, and all other objectionable material. Septic tanks, drain fields, and connection lines and any other underground structures, debris or waste shall be totally removed if they are found on

the site. All objectionable material from the clearing and grubbing process shall be removed from the site and wasted in approved safe locations.

C. Unless otherwise shown or specified, native trees larger than three inches in diameter at the base shall not be removed without the Engineer's approval. The removal of any trees, shrubs, fences, or other improvements outside of rights-of-way as deemed necessary by the Contractor, shall be arranged with the Owner, and be removed and replaced, at no additional cost to the Owner.

3.3 OVEREXCAVATION, REGRADING, AND BACKFILL UNDER FILL AREAS

A. After the fill areas have been cleared, grubbed, and excavated, the areas to receive fill will require overexcavation, regrading, and backfill, consisting of the removal and/or stockpiling of undesirable soils. The ground surface shall be recontoured for keying the fill and removing severe abrupt changes in the topography of the site. The overexcavated volumes shall be backfilled in accordance with Section 02200 – Earthwork, and as shown.

END OF SECTION

SECTION 02140 – DEWATERING

PART 1 GENERAL

1.1 THE REQUIREMENT

A. The Contractor shall provide all labor, materials and equipment necessary to dewater trench and structure excavations, in accordance with the requirements of the Contract Documents. The Contractor shall secure all necessary permits to complete the requirements of this Section of the Specifications.

B. Where shoring is not designed to resist hydrostatic pressures and dewatering systems need to be designed to draw down the groundwater level below the excavation bottom and below and beyond the excavation sidewalls. Piezometers (i.e., monitoring wells) should be installed adjacent to the excavation to monitor the groundwater levels prior to and while the excavation is open. The purpose of the piezometers is to confirm that the groundwater level is adequately lowered prior to and during excavation and shoring installation.

C. Groundwater dewatering wells, well points, and piezometers should be installed and removed in accordance with local requirements.

1.2 REFERENCE REPORTS

A. In preparing these Contract Documents, the Engineer has relied upon the following geotechnical work:

1. A Geotechnical Report has been prepared for this project. The report is entitled, ”Geotechnical Report – Brentwood Wastewater Treatment Plant Expansion Project,” September 12, 2017. An addendum to the Geotechnical Investigation Report was issued on February 27, 2018.

1.3 CONTRACTOR SUBMITTALS

A. Prior to commencement of excavation, the Contractor shall submit a detailed plan and operation schedule for dewatering of excavations. The Contractor may be required to demonstrate the system proposed and to verify that adequate equipment, personnel and materials are provided to dewater the excavations at all locations and times. The dewatering plan shall be prepared by a Civil Engineer licensed in the State of California. The Contractor’s dewatering plan is subject to review by the Engineer. Contractor dewatering recommendations during construction of the facilities shall be included as notes and details on the grading and/or Contract plans.

B. The detailed dewatering submittal shall be submitted and coordinated with the project shoring design submittal. The submittal shall include construction details for dewatering wells and piezometers, a scaled drawing(s) showing the isolation of all dewatering wells and piezometers (monitoring wells), a cross-section of a typical dewatering well with depth of well, diameter of drilled hole, diameter of casing, position of well screen, materials and gradation of filter pack, and position of pump, and a scaled drawing(s) of the layout of all discharge piping and sedimentation tanks/basins and ultimate discharge location.

C. The Contractor's dewatering and shoring submittal should contain alternative (i.e., contingent) systems, and the Contractor should be prepared to alter initial dewatering systems and/or implement alternative dewatering and shoring systems should the initial systems not achieve the above minimum requirements.

1.4 QUALITY CONTROL

A. It shall be the sole responsibility of the Contractor to control the rate and effect of the dewatering in such a manner as to avoid all objectionable settlement and subsidence.

B. All dewatering operations shall be adequate to assure the integrity of the finished project and shall be the responsibility of the Contractor.

C. Where critical structures or facilities exist immediately adjacent to areas of proposed dewatering, reference points shall be established and observed at frequent intervals to detect any settlement which may develop. The responsibility for conducting the dewatering operation in a manner which will protect adjacent structures and facilities rests solely on the Contractor. The cost of repairing any damage to adjacent structures and restoration of facilities shall be the responsibility of the Contractor.

PART 2 PRODUCTS

2.1 EQUIPMENT

A. Dewatering, where required, may include the use of well points, sump pumps, temporary pipelines for water disposal, rock or gravel placement, and other means. Standby pump equipment shall be maintained on the jobsite.

PART 3 EXECUTION

3.1 EXISTING CONDITIONS

A. Information on groundwater levels and soil conditions is included in the project Geotechnical Report. The Design groundwater elevation is 53 feet as recommended in the Geotechnical Report.

3.2 GENERAL REQUIREMENTS

A. The Contractor shall provide all equipment necessary for dewatering. It shall have on hand, at all times, sufficient pumping equipment and machinery in good working condition and shall have available, at all time, competent workmen for the operation of the pumping equipment. Adequate standby equipment shall be kept available at all times to insure efficient.

B. The Contractor is advised that the excavations are founded on permeable soils that may convey significant water into the bottom of the excavation and require dewatering from outside the excavation to bring the area groundwater level below the bottom of the excavation.

C. The Contractor is advised that whenever an excavation is near the backfill of an existing pipeline, that existing pipeline bedding and pipe zone backfill is composed of permeable material that will convey significant water. The Contractor shall provide dewatering outside of the excavation to control this water.

D. Dewatering for structures and pipelines shall commence when groundwater is first encountered, and shall be continuous until such times as water can be allowed to rise in accordance with the provisions of this section or other requirements.

E. Dewatering operations shall be coordinated with shoring or other excavation protection measures, as specified in Section 02390 – Shoring and Section 02200 – Earthwork, to maintain a safe working environment.

F. At all times, site grading shall promote drainage. Surface runoff shall be diverted from excavations. Rainwater entering the excavation shall be collected in shallow ditches around the perimeter of the excavation, drained to sumps, and be pumped or drained by gravity from the excavation to maintain a bottom free from standing water.

G. Dewatering shall at all times be conducted in such a manner as to preserve the undisturbed bearing capacity of the subgrade soils at proposed bottom of excavation.

H. If foundation soils are disturbed or loosened by the upward seepage of water or an uncontrolled flow of water, the affected areas shall be excavated and replaced with drain rock at no cost to the Owner.

I. The Contractor shall maintain the water level a minimum of 3 ft below and beyond the bottom of excavation in all work areas where groundwater occurs during excavation construction, backfilling, and up to acceptance. Excavation shall not proceed until monitoring wells (piezometers) demonstrate that groundwater has been drawn down a minimum of 3 feet below and 3 feet beyond the bottom of excavation.

J. Flotation shall be prevented by the Contractor by maintaining a positive and continuous removal of water. The Contractor shall be fully responsible and liable for all damages which may result from failure to adequately keep excavations dewatered.

K. If well points are used, they shall be adequately spaced to provide the necessary dewatering and shall be sandpacked and/or filtered to prevent pumping of fine sands or silts from the subsurface. Routine checking by the Contractor shall be maintained as required to ensure that the subsurface soil is not being removed by the dewatering operation. If well points or wells are used, a permit from applicable State and/or Local Authorities shall be obtained by the Contractor, as required. Wells, well points and piezometers shall be installed and removed or abandoned in accordance with State and/or Local requirements.

L. Previous water quality testing of groundwater by the City in the project area indicates that the following analytical tests may be required as part of the permits issued by the Regional Water Quality Control Board (RWQCB):

1. EPA Method 200.8 (metals)

2. EPA Method 200.7 (iron and boron)

3. EPA Method 245.1 (mercury)

4. EPA Method 300.0 (nitrite, nitrate+nitrite, chloride, sulfate

5. EPA Method 418.1 (petroleum hydrocarbons)

6. General testing for settleable solids and total suspended solids

M. The RWQCB has total jurisdiction regarding any discharges of ground water to the environment and will likely impose rigorous cleanup requirements if water quality testing of the groundwater indicates presence of constituents with limits regulated by the RWQCB. It is the responsibility of the Contractor to obtain necessary permits from the RWQCB and comply with all State of California requirements for any ground water discharged, including, but not limited to treatment of the discharged water.

N. The Contractor shall test water from dewatering activities to ensure compliance with RWQCB requirements. Contractor shall test water anytime modifications are made to dewatering systems and a least once per day during the duration of dewatering activities. The Contractor shall notify the Construction Manager when sampling and testing are to be completed to allow for Construction Manager inspection. The Contractor shall provide sampling points for the Owner to collect representative samples for Owner testing.

O. The Contractor shall dispose of water from the Work as required by the Regional Water Quality Control Board. No water shall be drained into work built or under construction without prior consent of the Engineer.

P. Water from dewatering activities shall be of a quality that meets the water quality requirements as identified in the RWQCB's permit. The dewatering activities shall not cause any nuisance issues associated with the disposal of groundwater. The Contractor shall be responsible for sampling and disposal of sediments collected in settling tanks and other waste materials related to groundwater disposal.

Q. The Owner will test water from dewatering activities to ensure compliance with water quality requirements. The Contractor shall provide sampling points for the Owner to collect representative samples required for testing.

R. The release of groundwater to its static level shall be performed in such a manner as to maintain the undisturbed state of the natural foundation soils, prevent disturbance of compacted backfill and prevent floatation or movement of structures, pipelines and sewers.

S. Dewatering of trenches and other excavations shall be considered as incidental to the construction of the Work and all costs thereof shall be included in the various contract prices of the Bid Forms, unless a separate bid item has been established for dewatering.

T. Groundwater that contains hazardous material or designated materials, or otherwise does not meet the water quality requirements for discharge to the Owner's stormwater collection system shall be treated to meet those requirements to allow discharge or shall be transported to an appropriate licensed liquid disposal facility.

U. Damage caused by dewatering shall be repaired at the Contractor's cost.

END OF SECTION

SECTION 02200 – EARTHWORK

PART 1 GENERAL

1.1 THE REQUIREMENT

A. This Section includes all earthwork required for construction of the Work. Such earthwork shall include, but not be limited to the loosening, removing, loading, transporting, depositing, and compacting in its final location, of all materials wet and dry, as required for the purposes of completing the Work specified in the Contract Documents. The Work shall also include the supporting of structures and utilities above and below the ground; all excavation and backfilling around structures and utilities and all excavation and backfilling of trenches and pits; the disposal of excess excavated materials; borrow and importing of materials to make up deficiencies for fills; and all other incidental earthwork, all in accordance with the requirements of the Contract Documents.

1.2 REFERENCE REPORTS

A. In preparing these Contract Documents, the Engineer has relied upon the following geotechnical work:

1. A Geotechnical Report has been prepared for this project. The report is entitled "Geotechnical Report – Brentwood Wastewater Treatment Plant Expansion Project," September 12, 2017. An addendum to the Geotechnical Investigation Report was issued on February 27, 2018.

2. The geotechnical information is separately available.

1.3 REFERENCE SPECIFICATIONS, CODES, AND STANDARDS

A. Specifications, Codes and Regulations:

1. California Department of Transportation Test Method Nos. 301 and 217.

2. Caltrans Standard Specifications, Latest Edition

3. U.S. Corp of Engineers, Specification CW-002215

B. Commercial standards:

ASTM D422	Method for Particle-Size Analysis of Soils.
ASTM D1556	Test Method for Density of Soil in Place by the Sand-Cone Method.
ASTM D1557	Test methods for Moisture-Density Relations of Soils and Soil-Aggregate Mixtures Using 10-lb (4.54-kg) Rammer and 18-in. (457-mm) Drop.
ASTM D2419	Test Method for Sand Equivalent Value of Soils and Fine Aggregate.
ASTM D2487	Classification of Soils for Engineering Purposes.

ASTM D2844	Resistance R-Value and Expansion Pressure of Compacted Soils.
ASTM D3744	Aggregate Durability Index.
ASTM D4253	Test Methods for Maximum Index Density of Soils Using a Vibratory Table.
ASTM D4254	Test Methods for Minimum Index Density of Soils and Calculation of Relative Density
ASTM D6938	Standard Test Methods for In-place Density and Water Content of Soil and Soil-Aggregate Nuclear Methods (Shallow Depth).

1.4 CONTRACTOR SUBMITTALS

A. Submittals shall be in accordance with Section 01340 – Shop Drawings, Product Data and Samples, and shall be provided to confirm that material to be used comply with information specified herein.

B. The Contractor's attention is directed to the provisions for "Shoring and Bracing Drawings" in Section 6705 of the California Labor Code. The Contractor, prior to beginning any trench or structure excavation 5 feet deep or over shall submit to the Owner and shall be in receipt of the Owner's written acceptance of the Contractor's detailed plan per Section 02390 – Shoring.

C. The Contractor shall submit a copy of the excavation permit issued by the California Department of Industrial Safety.

D. The Contractor shall submit samples of all materials proposed to be used in the work in accordance with the requirements in Section 01340 – Shop Drawings, Product Data and Samples. Sample sizes shall be as determined by the testing laboratory.

1.5 QUALITY ASSURANCE

A. General: It shall be the responsibility of the Contractor to accomplish the specified compaction for backfill or other earthwork. All soil testing will be performed and paid for by the Owner, retesting, shall be contract work with all costs borne by the Contractor.

B. Where soil material is required to be compacted to a percentage of maximum dry density, the maximum dry density at optimum moisture content shall be determined in accordance with ASTM D1557. Where cohesionless, free draining soil material is required to be compacted to a percentage of relative density, the calculation of relative density shall be determined in accordance with ASTM D4253 and ASTM D4254. Field density in-place tests shall be performed in accordance with ASTM D1556, ASTM D6938, or by such other means acceptable to the Engineer.

C. In case the tests of the fill or backfill show non-compliance with the required density, the Contractor shall accomplish such remedy as may be required to insure compliance. Subsequent testing to show compliance shall be by a testing laboratory selected by the Owner and shall be at the Contractor's expense.

D. Particle size analysis of soils and aggregates shall be performed using ASTM D422.

E. Determination of sand equivalent value shall be performed using ASTM D2419 or California Test Method No. 217, State of California, Department of Transportation.

PART 2 PRODUCTS

2.1 SUITABLE FILL AND BACKFILL MATERIAL REQUIREMENTS

A. General: Fill and backfill materials shall be suitable selected or processed clean, fine earth, rock, or sand, as specified herein, and shall be free from grass, roots, brush, or other vegetation. Fill and Backfill materials shall not contain rocks or lumps larger than 3 inches in greatest dimension. Fill and backfill materials to be placed within 12 inches of any structure or pipe shall be free of rocks or unbroken masses of earth materials having a maximum dimension larger than 3/4 inches.

B. Suitable Materials: Materials not defined as unsuitable below are defined as suitable materials and may be used in fills, backfilling and embankment construction subject to the indicated limitations.

C. Suitable materials may be obtained from on-site excavations, may be processed on-site materials or may be imported. If imported materials are required by this Section or to meet the quantity requirements of the project, the Contractor shall provide the imported materials at no additional expense to the Owner, unless a unit price item is included for imported materials in the bidding schedule. The Contractor shall designate the proposed import sources in advance and shall provide representative source samples to be tested prior to acceptance and use.

D. The import materials shall be non-expansive and have a Plasticity Index less than 12 percent and a Liquid Limit of 30 percent or less with a minimum friction angle of 34 degrees. The import material shall not contain rocks or lumps larger than 6 inches in greatest dimension and should not contain more than 15 percent of the material larger than 3 inches. These materials shall be free of organic debris or contaminated materials. Imported fill materials should be placed and compacted to a minimum of 90 percent relative compaction at a moisture content of about 2 percent over optimum as determined by the ASTM D-1557 (latest revision) test procedure.

2.2 SUITABLE MATERIALS:

A. Aggregate Base, Caltrans Class 2

1. Caltrans Class 2 Aggregate Base shall conform to Caltrans Standard Specifications, current edition, Section 26-1.02A “Class 2 Aggregate Base”.

    a. The Caltrans Class 2 Aggregate Base shall consist of crushed or fragmented particles.
    b. Coarse aggregate material retained in Number 4 sieve shall consist of material of which at least 25 percent by weight shall be crushed particles when tested in accordance with California Test 205.

2. The grading for ¾-inch maximum should be used for all installations under structures.

3. At the option of the Contractor, the grading for either the 1-1/2 inch maximum or 3/4-inch maximum shall be used for installations not under structures, except that

once a grading is selected the grading shall not be changed without the Engineer's written approval.

4. Recycled Class 2 Aggregate Base shall not be used.

B. Permeable Material, Caltrans Class 2

1. This material shall be used where “Gravel” is called out on the drawings.

2. Caltrans Class 2 Permeable Material shall conform to Caltrans Standard Specifications, Section 68-1.025

3. Unless otherwise shown, Geotextile Filter Fabric is not required when using this material in pipe trenches or beneath structures.

C. Coarse Drain Rock

1. Coarse Drain Rock shall be crushed (i.e. angular) and clean rock conforming to the following gradation requirements:

Sieve Size	Percent Passing
2-inch	100
1-1/2-inch	90-100
3/4-inch	0-15
3/8-inch	0-5
No. 200	0-2

2. When used as a bedding / backfill material in pipe trenches or beneath structures, Coarse Drain Rock shall be completely enclosed in Geotextile Filter Fabric to prevent contamination of the rock by surrounding soils.

D. Sand Backfill: Sand with 100 percent passing a 3/8-inch sieve, at least 90 percent passing a Number 4 sieve, and a sand equivalent value not less than 30.

E. Pea Gravel Backfill: Crushed rock or gravel with 100 percent passing a 1/2-inch sieve and not more than 10 percent passing a Number 4 sieve. Pea gravel shall only be used where indicated on the Contract Documents.

F. Trench Plug Material: Low permeability, non-dispersible clay fill material having a minimum plasticity index of 25 or Controlled Low Strength Material.

G. Geotextile Filter Fabric

1. The geotextile filter fabric shall be a non-woven material consisting of polyester, nylon, or polypropylene filaments formed into a stable network. The fabric shall be permeable, not act as a wicking agent, be inert to commonly encountered chemicals, be rot proof, and resistant to ultra-violet light.

2. The geotextile filter fabric shall also conform to the following physical properties:

Property	Test Value	Test Method
Weight	5.4 oz./yd. (min.)	ASTM D5261

Property	Test Value	Test Method
Grab tensile strength	150 lb. (min.)	ASTM D4632
Elongation at break	50 percent (max.)	ASTM D4632
Puncture strength	80 lb. (min.)	ASTM D4833
Burst strength	300 psi (min.)	ASTM D3786
Apparent opening size	#70 (max.)	ASTM D4751
Permeability	1.0 sec^{-1} (min.)	ASTM D4491
UV resistance	70 percent (min.)	ASTM D4355

3. Filter fabric shall be Mirafi 160N, or equal.

H. Controlled Low Strength Material (CLSM)

1. CLSM mix shall be composed of a cementitious material, water, fine and coarse aggregate, and an admixture. The cementitious material shall be Portland cement in combination with fly ash. The admixture shall be an air-entraining agent. The proportions of all material used in the CLSM shall conform to the mix design. CLSM shall have an unconfined compressive 28-day strength from a minimum of 50 psi to a maximum of 150 psi.

2. Aggregate content: Aggregates need not conform to ASTM C33. Any aggregates that produce performance characteristics of the CLSM may be submitted for approval. CLSM mixture shall contain no aggregate that is larger than 3/8-inch. The amount of material passing a No. 200 sieve shall not exceed 12 percent. No plastic fines shall be present.

3. Air content: The air content by volume based on measurement made immediately after discharge from the mixer shall be determined by ASTM C231. The total calculated air content of the sample prepared in accordance with ASTM C231 shall not exceed 6 percent.

4. Mix Design shall be as follows:

Material	Weight	Sp.Gr.	Abs.Vol.
Cement	30 lbs.	3.15	0.152
Fly Ash	300 lbs.	2.30	2.090
Water	317 lbs.	1.00	5.08
Coarse aggregate	1645 lbs.	2.68	8.76
Fine aggregate	1465 lbs.	2.68	9.835
Admixture	4 oz.	---	1.08
Total	3757 lbs.	---	27.0 cu.ft.

5. Provide the Engineer with delivery tickets for each truck load that shows the control density fill mix, the batch size, and the time batched.

6. Materials

a. Cement shall conform to ASTM C150, Type II. Fly ash shall conform to ASTM C618, Class F.
b. The fly ash shall not inhibit the entrainment air.
c. Air entraining admixture shall conform to ASTM C260.
d. Fine aggregate - No. 1 concrete sand. Coarse aggregate - No. 2, 3/8-inch pea gravel.

7. CLSM shall be batched by a ready mixed concrete plant and mixed and delivered to the jobsite by means of transit mixing trucks.

a. No equipment or traffic shall be allowed on the CLSM until the surface of the CLSM will withstand the weight of equipment or traffic without displacement or damage. If necessary to prevent displacement or damage, provide steel trench plates that span the trench or other means that prevent equipment or traffic contact with CLSM.

b. Take all precautions necessary to prevent the uplift or floating of the pipeline prior to the completion of the backfilling operation.

I. Low Expansive Fill

1. Low Expansive Fill material shall meet the following gradation requirements:

Sieve Size	Percent Passing
3"	100
3/4 "	60 – 100
No. 4	40 – 100
No. 200	5 – 40

2. Low Expansive Fill material shall meet the following quality requirements:

Parameter	Requirement
Plasticity Index	NP-12
Liquid Limit	Less than 30
Expansion Index (UBC 18-2)	Less than 20
R-Value	50 (minimum)
pH	>6
Saturated Resistivity	>2,500 ohm-cm
Total Water Soluble Chloride Concentration	<300 mg/kg
Total Water Soluble Sulfate Concentration	<1,000 mg/kg

3. The Low Expansive Fill material shall consist of a soil or soil rock mixture that is free of organic material or other deleterious substances.

J. Rip-Rap: In accordance with Caltrans Standard Specifications No. 2 Backing Class, installed as shown on the drawings. Minimum thickness of the rock surfacing, as measured perpendicular to the slope, shall be 9 inches. Rounded cobbles are not acceptable; angular shapes shall be used.

2.3 UNSUITABLE MATERIAL

A. Unsuitable materials include the materials listed below.

1. Soils which, when classified under ASTM D 2487 - Classification of Soils for Engineering Purposes, fall in the classifications of Pt, OH, CH, MH, or OL.

2. Soils which cannot be compacted sufficiently to achieve the density specified for the intended use. Note that soils shall not be termed unsuitable simply because they are over optimum moisture content. The Contractor shall at its cost blend, blade, aerate and dry these materials until optimum moisture is achieved.

3. Materials that contain hazardous or designated waste materials including petroleum hydrocarbons, pesticides, heavy metals, and any material which may be classified as hazardous or toxic according to applicable regulations.

4. Soils that contain greater concentrations of chloride or sulfate ions, or have a soil resistivity or pH less than the existing on-site soils.

5. Topsoil, except as allowed below.

B. All unsuitable material shall be disposed off site by the Contractor on a time and material basis.

2.4 SUITABLE NATIVE MATERIALS

A. Material excavated from the project site can be used on-site for fill applications provided it meets the specifications for the required material.

B. Additional information on the use of native material for construction materials can be found in the Geotechnical Report.

C. Topsoil, stripped from the site or otherwise procured, may be used to achieve final specified grades at the Work site to a maximum total topsoil depth of 6-inches. The topsoil can also be used to add up to 6 inches to the top of any landscaped levee, provided that the specified crest elevations are achieved with suitable material as specified above. Levees with roadways shall conform to the specifications and details for roadway installations. Crest elevations for levees with roadways shall be as shown on the Drawings. Topsoil may also be used to provide suitable soil for installation of landscaping at the Work site.

2.5 USE OF FILL, BACKFILL, AND EMBANKMENT MATERIAL TYPES

A. The Contractor shall use the types of materials as designated herein for all required fill, backfill, and embankment construction hereunder.

B. Where these Specifications conflict with the requirements of any local agency having jurisdiction or with the requirements of a pipe material manufacturer, the Engineer shall be immediately notified. In case of conflict between types of pipe embedment backfills, the Contractor shall use the agency-specified backfill material if that material provides a greater degree of structural support to the pipe, as determined by the Engineer. In case of conflict between types of trench or final backfill types, the Contractor shall use the agency-specified backfill material if that material provides the greater in-place density after compaction.

C. Fill and backfill types shall be used in accordance with the following provisions:

1. Embankments and Levees:

a. Embankment fill and earthwork shall be constructed of material from on-site excavations/borrow sites meeting the requirements of 2.1 or Low Expansive Fill. Use of suitable on-site soils is acceptable, provided that the minimum compaction requirements specified herein can be met.

b. Levees and other water-retaining earthen berms shall be constructed of material from on-site excavations/borrow sites meeting the requirements of 2.1 or Low Expansive Fill material.

2. Pipelines

a. Pipe bedding shall be ¾-inch maximum Caltrans Class 2 Aggregate Base.
b. Pipe zone backfill shall be sand backfill as specified in paragraph 2.2 D, unless otherwise specified.

c. Pipe bedding and pipe zone backfill for tape-wrapped steel pipe shall be Controlled Density Fill.

d. Backfill used to replace pipe trench over-excavation and provide a stable working surface in wet trench conditions shall be a 12-inch thick (minimum) layer of Coarse Drain Rock wrapped in Geotextile Filter Fabric.

e. Trench zone backfill in landscaped areas and unimproved areas may consist of suitable on-site soils obtained from on-site excavations/borrow sites, provided that the minimum compaction requirements specified herein can be met, or Low Expansive Fill.

f. Trench backfill and final backfill for pipelines under structures shall be ¾-inch maximum Caltrans Class 2 Aggregate Base., except where concrete encasement is required.

g. Final backfill material for pipelines under pavements, sidewalks, curbs, gutters, equipment pads and other surface improvements shall be Caltrans Class 2 Aggregate Base unless otherwise specified. Final backfill under areas not paved shall be the same material as that used for trench backfill, except that topsoil material shall be used for final backfill in landscaped areas unless otherwise indicated.

h. Where pipelines are installed on grades exceeding 4 percent, and where backfill materials are graded such that there is less than 10 percent passing a Number 4 sieve, Trench Plug Material shall be provided at maximum intervals of 200 feet unless indicated otherwise. Trench Plug Material shall also be provided at edges of structure footings where pipeline passes beneath structures, with the Trench Plug Material lapping the footing edge to provide a complete seal against migration of water.

3. Structures

a. Backfill around structures shall be material from on-site excavations meeting the requirements of 2.1 or Low Expansive Fill, except as shown or

otherwise specified.

b. Drainrock materials under hydraulic structures or other water retaining structures with underdrain systems shall be Class 2 Permeable Material without Geotextile Filter Fabric, or Coarse Drain Rock completely enclosed in Geotextile Filter Fabric.

c. Under concrete hydraulic structures or other water retaining structures without underdrain systems, Caltrans Class 2 Aggregate Base shall be used.

d. Under structures where groundwater must be removed to allow placement of concrete, Class 2 Permeable Material without Geotextile Filter Fabric, or Coarse Drain Rock completely enclosed in Geotextile Filter Fabric shall be used.

e. Under all other structures, Caltrans Class 2 Aggregate Base shall be used.

4. Aggregate base materials under pavements, sidewalks, curbs, gutters, equipment pads and other surface improvements shall be Caltrans Class 2 Aggregate Base constructed to the thicknesses indicated.

2.6 MATERIALS TESTING

A. Soils testing shall be performed according to the requirements of Section 01400 – Quality Control.

B. The Contractor shall, at his expense, test all imported materials for the Work according to the following testing protocols.

1. The required number of discrete soil samples from each import source that must be collected for testing by the Contractor is detailed in the following table. Multiple samples, according to the same sampling schedule, will be collected for submission in compliance with the requirements of this Section and Section 01340 – Shop Drawings, Product Data and Samples.

Volume of Soil From a Single Source Location	**Samples Per Volume**
Up to 1,000 cubic yards	1 sample per 250 cubic yards
1,000 to 5,000 cubic yards	4 samples for the first 1,000 cubic yards plus 1 sample per each additional 500 cubic yards
Greater than 5,000 cubic yards	12 samples for the first 5,000 cubic yards plus one sample for each 1,000 cubic yards

2. Results from all testing shall be submitted to the Engineer according to Section 01340 – Shop Drawings, Product Data and Samples for approval a minimum of two weeks prior to planned import to the Work site. If imported soil is found to

contain concentrations of constituents that exceed USEPA Maximum Contaminant Levels (as specified in the most recent version of the Soil Screening Guidance document), the Engineer will reject the submittal and the Contractor will be required to obtain the imported material from a source that does not contain problematic concentrations of the test targets.

3. Any rejected materials already imported to the site shall be treated as Unsuitable Materials and shall be disposed of according to Section 2.3 of this Specification.

4. For each source of imported material sieve size analysis, plasticity index, liquid limit, expansion index (UBC 18-2) and permeability shall be analyzed with results submitted to the Engineer according to Section 01340 – Shop Drawings, Product Data and Samples for approval a minimum of two weeks prior to planned import to the Work site.

5. Total Petroleum Hydrocarbons (TPH) as gasoline, diesel and motor oil shall be tested for according to EPA Method 8015 Modified.

6. Volatile Organic Compounds (VOCs) including benzene, toluene, ethyl-benzene, xylenes (BTEX) and methyl-tertiary-butyl-ether (MTBE) shall be tested for according to EPA Method 8260 or equivalent.

7. Semi Volatile Organic Compounds (SVOCs) shall be tested for according to EPA Method 8270 or equivalent.

8. California Assessment Metals (CAM 17) shall be tested for according to EPA Method 6000 series.

9. Polychlorinated Biphenyls (PCBs) and pesticides shall be tested for according to EPA Method 8081/8082 or equivalent.

C. Particle size analysis of soils and aggregates will be performed using ASTM D 422 - Method for Particle-Size Analysis of Soils.

D. Determination of sand equivalent value will be performed using ASTM D 2419 - Test Method for Sand Equivalent Value of Soils and Fine Aggregate.

E. Unified Soil Classification System: References in this Section to soil classification types and standards shall have the meanings and definitions indicated in ASTM D 2487. The Contractor shall be bound by all applicable provisions of said ASTM D 2487 in the interpretation of soil classifications.

F. The testing for chloride, sulfate, resistivity, and pH will be done in accordance with California Test Methods 532 and 643 of the California Department of Transportation.

PART 3 EXECUTION

3.1 EXCAVATION - GENERAL

A. General: Except when specifically provided to the contrary, excavation shall include the removal of all materials of whatever nature encountered, including all obstructions of any nature that would interfere with the proper execution and completion of the Work. The removal of said materials shall conform to the lines and grades indicated or ordered. Unless otherwise indicated, the entire construction site shall be stripped of all

vegetation and debris, and such material shall be removed from the site prior to performing any excavation or placing any fill. The Contractor shall furnish, place, and maintain all supports and shoring that may be required for the sides of the excavations. Excavations shall be sloped or otherwise supported in a safe manner in accordance with applicable State safety requirements and the requirements of OSHA Safety and Health Standards for Construction (29CFR1926).

B. Removal and Exclusion of Water: The Contractor shall remove and exclude water, including stormwater, groundwater, irrigation water, and wastewater, from all excavations as specified in Section 02140 - Dewatering. Dewatering wells, wellpoints, sump pumps, or other means shall be used to remove water and continuously maintain groundwater at a level at least three feet below and beyond the excavation bottom, slopes, and sidewalls before the excavation work begins at each location. Water shall be removed and excluded until backfilling is complete and all field soils testing has been completed.

C. Soils that are excavated at a moisture content higher than the optimum moisture content for the specified levels of compaction, are classified as suitable material and are intended to be used in subsequent Work at the site, shall be mixed with dry material, air dried or otherwise conditioned to provide the optimum moisture content for compaction.

D. Earthwork shall be performed in accordance with the requirements described in the Geotechnical Report identified in Section 1.2A.1.

3.2 STRUCTURE, ROADWAY, AND EMBANKMENT EXCAVATION

A. Excavation Beneath Structures and Embankments: Subgrade preparation should extend a minimum of 5 feet beyond the outermost limits of the proposed improvements, unless it is restricted by existing improvements. Except where otherwise indicated for a particular structure or ordered by the Engineer, excavation shall be carried to the grade of the bottom of the subgrade layer. Where indicated or ordered, areas beneath structures or fills shall be over-excavated. The subgrade areas beneath embankments shall be excavated to remove not less than the top 12 inches of native material, or as otherwise specified, and where such subgrade is sloped, the native material shall be benched. When such over-excavation is indicated, both over-excavation and subsequent backfill to the required grade shall be performed by the Contractor. When such over-excavation is not indicated but is ordered by the Engineer, payment will be made in accordance with a negotiated price. After the required excavation or over-excavation has been completed, the exposed surface shall be scarified to a depth of 12 inches, brought to optimum moisture content, and rolled with heavy compaction equipment to obtain 95 percent of maximum density.

B. Excavation Beneath Concrete Hydraulic Structures: Excavation under structures shall extend to the bottom of the subgrade layer. After such excavation has been completed, the exposed surface shall be rolled with heavy compaction equipment to 95 percent of maximum density and then graded to provide a reasonably smooth surface for placement of the subgrade. Areas under the structures upon which subgrade/fill is to be placed shall be scarified to a depth of 12 inches, brought to optimum moisture content, and compacted to obtain 95 percent of maximum density.

C. Excavation Beneath Paved Areas: The subgrade areas beneath paved areas shall be excavated to remove not less than the top 12 inches of native material, or as otherwise specified, and where such subgrade is sloped, the native material shall be benched. Excavation under areas to be paved shall extend to the bottom of the aggregate base or

subbase, if such base is called for; otherwise it shall extend to the paving thickness. After the required excavation has been completed, the top 12 inches of exposed surface shall be scarified, brought to optimum moisture content, and rolled with heavy compaction equipment to obtain 95 percent of maximum density. The finished subgrade shall be even, self-draining, and in conformance with the slope of the finished pavement. Areas that could accumulate standing water shall be regraded to provide a self-draining subgrade.

D. Notification of Engineer: The Contractor shall notify the Engineer at least 48 hours in advance of completion of any structure excavation and shall allow the Engineer a review period of at least one day before the exposed foundation is scarified and compacted or is covered with backfill or with any construction materials.

3.3 PIPELINE AND UTILITY TRENCH EXCAVATION

A. General: Unless otherwise indicated or ordered, excavation for pipelines and utilities shall be open-cut trenches with widths as indicated.

B. Trench Bottom: Except when pipe bedding is required, the bottom of the trench shall be excavated uniformly to the grade of the bottom of the pipe bedding. Excavations for pipe bells and welding shall be made as required.

C. Open Trench: The maximum amount of open trench permitted in any one location shall be the length necessary to accommodate the amount of pipe installed in a single day. Where pipelines are constructed in public rights of way, the Encroachment Permit may have more restrictive open trench limitations which shall be fully complied with.

All trenches within traffic areas and roads shall be fully backfilled at the end of each day or, in lieu thereof, shall be covered by heavy steel plates of 1-inch minimum thickness adequately braced and capable of supporting vehicular traffic in those locations where it is impractical to backfill at the end of each day. The above requirements for backfilling or use of steel plate will be waived in cases where the trench is located further than 100 feet from any traveled roadway or occupied structure. In such cases, however, barricades and warning lights meeting safety requirements shall be provided and maintained and no section of trench can be left open for more than two weeks. The Engineer may designate a passage to be provided at any point deemed necessary.

1. For trench excavation within the existing Wastewater Treatment Facility or along any access route required for operation of the existing Wastewater Treatment Facility, the Contractor shall provide access for facility operators at all times.

2. Access to fire hydrants shall be maintained at all times.

D. Trench Depth: Trenches shall be excavated to the bottom of the bedding and to the depth shown on the contract documents.

E. Over-Excavation to Provide Stable Excavation Bottom: If ordered by the Engineer, whether indicated on the Drawings or not, trenches shall be over-excavated beyond the depth and/or width shown to provide a stable excavation bottom. Such over-excavation shall be to the dimensions ordered. The trench shall then be backfilled to the grade of the bottom of the pipe bedding.

F. Additional Trench Depth to Avoid Conflict with Existing Infrastructure: Over-excavation up to 12 inches below the limits on the drawings shall be done at no increase in cost to the Owner, when required to avoid conflict with existing infrastructure. If needed addition excavation depth is greater than 12 inches below the limits shown, or wider by more than 12 inches, additional payment will be made to the Contractor for the additional excavation and backfill beyond the initial 12 inches. Said payment will be made to the Contractor as a negotiated payment item.

G. Where pipelines are to be installed in embankments, fills, or structure backfills, the fill shall be constructed to a level at least one foot above the top of the pipe before the trench is excavated.

3.4 OVER-EXCAVATION NOT ORDERED OR INDICATED

A. Any over-excavation carried below the grade ordered or indicated, shall be backfilled to the required grade with the indicated material and compaction. Such work shall be performed by the Contractor at no additional cost to the Owner.

3.5 EXCAVATION IN LAWN AREAS

A. Where excavation occurs in lawn areas, the sod shall be carefully removed, dampened, and stockpiled to preserve it for replacement. Excavated material may be placed on the lawn; provided, that a drop cloth or other suitable method is employed to protect the lawn from damage. The lawn shall not remain covered for more than 72 hours. Immediately after completion of backfilling and testing of the pipeline, the sod shall be replaced and lightly rolled in a manner so as to restore the lawn as near as possible to its original condition. Contractor shall provide new sod if stockpiled sod has not been replaced within 72 hours.

3.6 EXCAVATION IN VICINITY OF TREES

A. Except where trees are indicated to be removed, trees shall be protected from injury during construction operations. No tree roots over 2 inches in diameter shall be cut without express permission of the Engineer. Trees shall be supported during excavation by any means previously reviewed by the Engineer.

B. Explosives and Blasting: Blasting will not be permitted.

3.7 DISPOSAL OF EXCESS EXCAVATED MATERIAL

A. The Contractor shall remove and dispose of all excess unsuitable excavated material, except topsoil, at a site selected by the Contractor.

B. The Contractor shall obtain all required permits, landowner, and agency approvals for disposal of excess unsuitable excavated material on a time and material basis.

3.8 BACKFILL - GENERAL

A. Backfill shall not be dropped directly upon any structure or pipe. Backfill shall not be placed around or upon any structure until the concrete has attained sufficient strength to withstand the loads imposed. Backfill around water retaining structures shall not be placed until the structures have been tested, and the structures shall be full of water while backfill is being placed.

B. Except for drainrock materials being placed in over-excavated areas or trenches, backfill shall be placed after all water is removed from the excavation, and the trench sidewalls and bottom have been dried to a moisture content suitable for compaction.

C. If a moveable trench shield is used during excavation, pipe installation, and backfill operations, the shield shall be moved by lifting the shield free of the trench bottom or backfill and then moving the shield horizontally, The Contractor shall not drag trench shields along the trench causing damage or displacement to the trench sidewalls, the pipe, or the bedding and backfill.

D. Immediately prior to placement of backfill materials, the bottoms and sidewalls of trenches and structure excavations shall have all loose sloughing, or caving soil and rock materials removed. Trench sidewalls shall consist of excavated surfaces that are in a relatively undisturbed condition before placement of backfill materials.

3.9 PLACING AND SPREADING OF BACKFILL MATERIALS

A. Backfill materials shall be placed and spread evenly in layers not to exceed 8-inches in loose thickness for fill and embankment material and 6-inches in loose thickness for pipe zone backfill material.

B. During spreading, each layer shall be thoroughly mixed as necessary to promote uniformity of material in each layer. Pipe zone backfill materials shall be manually spread around the pipe so that when compacted the pipe zone backfill will provide uniform bearing and side support.

C. Where the backfill material moisture content is below the optimum moisture content, water shall be added before or during spreading until the proper moisture content is achieved.

D. Where the backfill material moisture content is too high to permit the specified degree of compaction the material shall be dried until the moisture content is satisfactory.

3.10 COMPACTION OF FILL, BACKFILL, AND EMBANKMENT MATERIALS

A. Each layer of fill and backfill materials as defined herein, where the material is graded such that at least 10 percent passes a No. 4 sieve, shall be mechanically compacted to the specified percentage of maximum density. Equipment that is consistently capable of achieving the required degree of compaction shall be used and each layer shall be compacted over its entire area while the material is at the required moisture content. Lightweight tampers or vibrating plate compactors shall be used in pipeline and utility trenches to prevent damage to existing or new utilities. All areas to receive fill shall be scarified to a minimum depth of 12 inches and compacted to a minimum 90 percent of maximum dry density. Fill materials shall be spread evenly and compacted in uniform lifts not exceeding 8 inches in un-compacted thickness.

B. Coarse Drain Rock and Pea Gravel materials shall be compacted by means of at least 2 passes from a flat plate vibratory compactor. When such materials are used for pipe zone backfill, vibratory compaction shall be used at the top of the pipe zone or at vertical intervals of 24 inches, whichever is the least distance from the subgrade.

C. Backfill around and over pipelines that is mechanically compacted shall be compacted using light, hand operated, vibratory compactors and rollers. After completion of at

least two feet of compacted backfill over the top of pipeline, compaction equipment weighing no more than 8,000 pounds may be used to complete the trench backfill.

D. Compaction of backfill adjacent to all subgrade structure walls shall follow a pattern of compaction that begins at the wall face and progresses outward to the outside edge of the excavation before beginning a new lift.

E. Equipment weighing more than 10,000 pounds shall not be used closer to walls than a horizontal distance equal to the depth of the fill at that time. Hand operated power compaction equipment shall be used where use of heavier equipment is impractical or restricted due to weight limitations.

F. Flooding, ponding, or jetting shall not be used with the exception that jetting may be used to fill the remaining leach pits within the percolation ponds as described in the contract drawings.

G. Compaction Requirements. The following compaction test requirements shall be in accordance with ASTM D1557. Where agency or utility company requirements govern, the highest compaction standards shall apply. All fill and backfill materials shall be compacted to a minimum of 90 percent of maximum dry with the exception of the following:

Location or Use of Fill	Percentage of Maximum Density
Pipe bedding and over-excavated zones under bedding including trench plugs.	95
Pipe zone backfill pipe.	90
Trench zone backfill, beneath paved areas and structures, including trench plugs.	95
Trench zone backfill, not beneath paved areas or structures, including trench plugs.	90
Final backfill, beneath paved areas or structures.	95
Final backfill, not beneath paved areas or structures.	90
Embankments and fills.	95
Backfill beneath structures and hydraulic structures.	95
Backfill around structures within 5 ft of finish grade.	95
Backfill around structures where 5 ft or more below finish grade.	90
Topsoil	80
Caltrans Class 2 Aggregate Base	95

3.11 PIPE AND UTILITY TRENCH BACKFILL

A. If a moveable trench shield/shoring is used during backfill operations the shield shall be lifted to a location above each layer of backfill material prior to compaction of the layer. The Contractor shall remove shield/shoring in a manner and sequence that (1) is in step with the backfilling sequence (i.e., shield/shoring should not be removed ahead of backfilling), (2) does not cause loosening or shifting of backfill particularly within pipe embedment material, and (3) does not damage the finished pipeline or structures or existing structures, pavements, and utilities including through settlement, heave, or vibrations. Any void spaced created by shoring removal should be completely filled with CLSM or approved equivalent.

B. Pipe Zone Backfill

1. The pipe zone is defined as that portion of the vertical trench cross-section lying between a plane at the bottom of the pipe bedding material, i.e., the trench subgrade, and a plane at a point 12 inches above the top surface of the pipe.

2. The bedding is defined as that portion of pipe zone backfill material between the trench subgrade and the bottom of the pipe. Pipe bedding thickness shall be as shown on the Drawings.

3. After compacting the bedding, the Contractor shall perform a final trim using a stringline for establishing grade, such that each pipe section when first laid will be continually in contact with the bedding along the extreme bottom of the pipe. Excavation for pipe bells and welding shall be made as required.

4. The pipe zone shall be backfilled with the specified backfill material as specified in the Contract Documents. The backfill material for sewer and water lines shall be coarse sand as specified in Section 2.2 D. The Contractor shall exercise care to prevent damage to the pipeline coating, cathodic bonds, and the pipe itself during the installation and backfill operations.

C. Trench Zone Backfill

1. After the pipe zone backfill has been placed as specified above, backfilling of the trench zone may proceed. The trench zone is defined as that portion of the vertical trench cross-section lying between a plane 12 inches above the top surface of the pipe and a plane at the finished surface grade, or if the trench is under pavement below the roadway subgrade.

2. Final Backfill: Final backfill is all backfill in the trench zone cross-sectional area within 36 inches of finished grade, or if the trench is under pavement, all backfill within 36 inches of the roadway subgrade. Final backfill is reduced to extent of trench backfill zone where specified or required pipeline installation does not accommodate the 36 inches final backfill

D. Over-excavation Zone: The over-excavation zone shall be excavated and backfilled as required to meet the specifications of Section 02500 – Buried Pipe Installation and the other requirements of this Specification.

E. Periodic compliance tests may be made by the Engineer at no cost to the Contractor to verify that compaction is meeting the specified requirements.

F. If compaction fails to meet the specified requirements, the Contractor shall remove and replace the backfill at proper compaction or shall increase the compaction to specified level by other means acceptable to the Engineer. Subsequent tests required to verify that the reconstructed backfill meets the specified compaction shall be paid by the Contractor.

G. Trench plugs shall be installed to be keyed into the trench subgrade and the native material on the sides of the trench a minimum of 6-inches.

3.12 FILL AND EMBANKMENT CONSTRUCTION

A. The area where a fill or embankment is to be constructed shall be cleared of all vegetation, roots and foreign material. Following this, the surface shall be moistened, scarified to a depth of 12 inches, and rolled or otherwise mechanically compacted. Embankment and fill material shall be placed and spread evenly in approximately horizontal layers. Each layer shall be moistened or aerated, as necessary. Unless otherwise approved by the Engineer, each layer shall not exceed 6 inches of compacted thickness. The embankment, fill, and the scarified layer of underlying ground shall be compacted to 95 percent of maximum density under structures and paved areas, and 90 percent of maximum density elsewhere.

B. When an embankment or fill is to be made and compacted against hillsides or fill slopes steeper than 4:1, the slopes of hillsides or fills shall be horizontally benched to key the embankment or fill to the underlying ground. A minimum of 12 inches normal to the slope of the hillside or fill shall be removed and re-compacted as the embankment or fill is brought up in layers. The minimum horizontal dimension of 12 inches for benches should be extended as needed so as to key into competent soils. Material thus cut shall be re-compacted along with the new material at no additional cost to the Owner. Hillside or fill slopes 4:1 or flatter shall be prepared in accordance with Paragraph A, above.

C. Where embankment or structure fills are constructed over pipelines, the first 4 feet of fill over the pipe shall be constructed using light placement and compaction equipment that does not damage the pipe. Heavy construction equipment shall maintain a minimum distance from the edge of the trench equal to the depth of the trench until at least 4 feet of fill over the pipe has been completed.

3.13 FIELD TESTING

A. General: All field soils testing will be done by a testing laboratory of the Owner's choice at the Owner's expense except as indicated below.

B. Where soil material is required to be compacted to a percentage of maximum density, the maximum density at optimum moisture content will be determined in accordance with Method C of ASTM D 1557. Where cohesionless, free draining soil material is required to be compacted to a percentage of relative density, the calculation of relative density will be determined in accordance with ASTM D 4253 and D 4254. Field density in-place tests will be performed in accordance with ASTM D 1556 - Test Method for Density and Unit Weight of Soil in Place by the Sand-Cone Method, ASTM D 6938 - Standard Test Methods for In-place Density and Water Content of Soil and Soil-Aggregate Nuclear Methods (Shallow Depth), or by such other means acceptable to the Engineer.

C. In case the test of the fill or backfill show non-compliance with the required density, the Contractor shall accomplish such remedy as may be required to insure compliance. Subsequent testing to show compliance shall be by a testing laboratory selected by the Owner and shall be at no additional cost to the Owner.

D. The Contractor shall provide test trenches and excavations including excavation, trench support, and groundwater removal for the Owner’s field soils testing operations. The trenches and excavations shall be provided at the locations and to the depths required by the Owner. All Work for test trenches and excavations shall be provided at no additional cost to the Owner.

END OF SECTION

SECTION 02255 – STONE COLUMNS

PART 1 GENERAL

1.1 THE REQUIREMENT

A. The work shall be performed by a SPECIALTY SUBCONTRACTOR who can meet the design requirements as outlined below. The SPECIALTY SUBCONTRACTOR shall coordinate his work with the CONTRACTOR.

B. The SPECIALTY SUBCONTRACTOR shall provide all engineering, supervision, labor, materials, equipment, and related services necessary to densify the liquefiable sands and silty sand and structurally reinforce the more cohesive soils (i.e., silts and clays) by improving the soil with the construction of stone columns in the areas shown on Sheet G-13 of the Contract Drawings and to the elevations and design criteria specified herein.

C. The work shall include the following:

1. The SPECIALTY SUBCONTRACTOR shall be responsible for preparing a ground improvement design to achieve the liquefaction mitigation and foundation support criteria described herein and in the Contract Documents referenced herein. The design shall be reviewed and approved by the Engineer.

2. The ground improvement design shall consider anticipated ground vibrations produced by stone column construction and the potential damaging effect they may have on existing improvements. Where ground improvement is required in areas containing and in proximity to existing structures, piping and underground utilities, and damaging ground vibrations are anticipated, an alternative ground improvement technique, such as jet grouting in accordance with Section 022556 - Jet Grouting, shall be employed.

3. Construction of the stone columns including layout work.

4. Furnishing crushed stone for the stone columns.

5. Furnishing equipment, electrical power, water and any other necessary items for the stone column construction.

6. Control and disposal of water (surface and subsurface byproduct water) resulting from the stone column construction.

7. Construction of working pad necessary for the stone column construction.

8. Construction and removal of silt settling ponds (or similar) as required, and the regrading of site areas disturbed by the stone column construction.

9. Stockpiling and disposal of clay, silt, and organic materials washed up from stone column construction, if necessary.

10. Maintaining daily field records as specified.

1.2 RELATED WORK SPECIFIED ELSEWHERE

A. Section 02100 - Site Preparation

B. Section 02140 - Dewatering

C. Section 02200 – Earthwork

D. Section 02255 – Jet Grouting

1.3 REFERENCE SPECIFICATIONS, CODES, AND STANDARDS

A. The test methods listed below form a part of this specification to the extent referenced. The publications are referenced to the text by the basic designation American Society for Testing and Materials only (ASTM) and Caltrans Test Methods:

ASTM C29 Standard Test Method for Unit Weight and Voids in Aggregate.

ASTM C88 Standard Test Method for Soundness of Aggregates by Use of Sodium Sulfate or Magnesium Sulfate.

ASTM C131 Standard Test Method for Resistance to Degradation of Small-size Coarse Aggregate by Abrasion and Impact in the Los Angeles Machine.

California Test 229 Method of Test for Durability Index.

ASTM D1586 Standard Test Method for Penetration Test and Split-Barrel Sampling of Soils

ASTM D2487 Standard Practice for Classification of Soils for Engineering Purposes (Unified Soil Classification System).

ASTM D5778 Standard Test Method for Performing Electronic Friction Cone and Piezocone Penetration Testing of Soil

1.4 DEFINITIONS AND ABBREVIATIONS

A. Definitions:

<u>Stone columns</u>: stone column construction is accomplished by down-hole vibratory methods, typically referred to as vibro-replacement. A vibrating probe penetrates the ground, either by its own weight or aided by water jetting, to the treatment depth. Stone backfill is then introduced in controlled lifts, either from the surface down the annulus created by penetration of the probe (top feed) or through feeder tubes directed to the tip of the probe (bottom feed). Re-penetration of each stone backfill lift with the vibrating probe forces the stone column radially into the surrounding in-situ ground, forming a stone column that is tightly interlocked with the soil.

B. Abbreviations

1. CPT: Cone Penetration Test

2. $(N_1)_{60cs}$: Equivalent clean sand normalized SPT blow count

3. SPT: Standard Penetration Test

4. $(Q_{c1N})_{cs}$: Equivalent clean sand normalized CPT penetration resistance

1.5 SUBSURFACE CONDITIONS

A. A geotechnical report has been prepared for this project, including subsurface borings, cone penetration testing (CPTs), laboratory testing, and review of previous investigations. The report is entitled "Geotechnical Investigation Report, Brentwood Wastewater Treatment Plant Expansion Project, Brentwood, California", dated September 12, 2017, prepared by Cal Engineering & Geology, Inc. An addendum to the Geotechnical Investigation Report was issued on February 27, 2018.

A geotechnical report has been prepared for the 2001/2002 plant expansion, including subsurface borings, cone penetration testing (CPTs), test pits, shallow excavations, and laboratory testing. The report is entitled "Geotechnical Engineering Investigation Report, City of Brentwood, Brentwood Wastewater Treatment Plant Expansion Project, Brentwood, California", dated January 2000, prepared by DCM/Joyal Engineering.

Geotechnical information collected during the construction of the existing ground improvement during the Phase I treatment plant construction is available in electronic (PDF) format from the City.

B. The geology at the project site is diverse. In general, the subsurface investigation encountered near-surface deposits consisting of existing fill, sand dune deposits, and clayey deposits. The SPECIALTY CONTRACTOR is responsible for reviewing the available subsurface information pertaining to the site.

1.6 SYSTEM DESCRIPTION

A. The purpose of the subsurface soil improvement program is to reduce the potential for liquefaction, improve bearing capacity, and reduce both static and seismic settlements.

B. Design Requirements: The construction procedures, the specific equipment to be used, and the size and spacing of the stone columns shall be determined by the Specialty Contractor to achieve the acceptance criteria specified below in the Tolerance and Acceptance Criteria. Such procedures and related information shall be subject to the approval of the Engineer. However, the following general equipment and construction procedures shall be met.

1. The stone columns shall be designed to support foundation loads for the structures shown on Sheet G-13 included in the project plans. In addition, the design shall reduce the estimated post-liquefaction total and differential settlement to no greater than 1-inch and ½-inch, respectively.

2. The stone columns shall be installed in a grid pattern with a center-to-center spacing of not greater than 10 feet. The area treated with stone columns shall extend at least 15 feet beyond each building perimeter. A minimum of 2 rows of stone columns shall be constructed beyond each building perimeter.

3. The contractor shall use a down-hole vibrator capable of at least 80 HP and 15 tons of force.

4. The contractor shall not use water jets to aid the advance of the vibrator or assist the installation of the stone column.

5. After penetration to the full treatment depth, the vibrator shall be slowly retrieved in maximum lifts of 4 ft. increments to allow for backfill placement.

6. The vibrator shall be re-driven through each increment into recently treated depth interval to observe amperage build up in the cohesionless soils.

C. Tolerance and Acceptance Criteria:

1. A grid pattern depicting the placement of the stone columns that will provide the desired improvement in the cohesionless soils shall be developed by the Specialty Contractor and reviewed by the Engineer. The spacing should not be wider than 10 feet between the centers of the stone columns. The diameter of the stone columns should not be less than 2 feet.

2. The Specialty Contractor shall densify the cohesionless soils to the indicated depths to the following criteria when analyzed by the Cone Penetration Test (CPT).

   Minimum Corrected "clean sand" equivalent Q_{c1N} value = 140

   Average Corrected "clean sand" equivalent Q_{c1N} value = 160

   The average and minimum corrected "clean sand" equivalent Q_{c1N} values shall be determined from CPT soundings located at the midpoint between the groups of stone columns at each selected test location. The "clean sand" equivalent Q_{c1N} and Ic index values shall be calculated using the 1998 NCEER workshop procedures.

3. Corrected "clean sand" equivalent Q_{c1N} values obtained in soils that have an Ic index value of 2.5 will be excluded in determining the average corrected N-value at a test location. In addition, the minimum corrected "clean sand" equivalent Q_{c1N} value criteria will not be applied to these soils.

4. The CPT Qc-values obtained at test locations after soil densification shall be corrected for effective overburden pressure. Effective overburden pressures shall be calculated based on the ground surface elevations at the time of the CPT.

5. All CPT testing to determine specification compliance shall be provided by the Owner. The CPT soundings should be advanced to a minimum depth of 50 feet below the elevation of the finished ground surface.

6. Vibration Control: A total peak particle velocity of 0.5 inches per second shall not be exceeded at existing structures, utilities, or other improvements on or adjacent to the site. For areas where vibrations are anticipated to cause damage to existing improvements, other methods of ground improvement, such as jet grouting in accordance with Section 02256, shall be employed.

7. Settlement Control: Ground surface settlement (or heave) at existing structures, utilities, or other improvements on or adjacent to the site shall be limited to 0.2 inches or less.

8. The CONTRACTOR shall repair any damage resulting from vibrations or surface settlement or heave caused by stone column installation.

D. Documentation:

1. Any proposed change in the approved construction program, necessitated by a change in the subsurface conditions, shall be submitted in writing to the Engineer for approval.

2. A daily log shall be submitted to the Engineer by the Specialty Contractor to include probe number, start/finish time of probe, depth of treatment, approximate backfill quantities, and indication of relative amperage readings.

1.7 SPECIALTY SUBCONTRACTOR QUALIFICATIONS

A. The SPECIALTY SUBCONTRACTOR shall be regularly engaged in ground improvement by stone columns and shall document that they have performed a minimum of the following work in the United States:

Provided all supervision, labor, material and equipment to have successfully installed stone columns on 15 separate projects ranging in depth from 20 to 50 feet. Five of the documented, successfully completed projects shall be similar to this project in type of soil to be improved, dimension of stone columns, and equipment type used.

1.8 CONTRACTOR SUBMITTALS

A. Submit qualifications of SPECIALTY SUBCONTRACTOR. CONTRACTOR shall submit SPECIALTY SUBCONTRACTOR's qualifications to the ENGINEER for approval prior to the preconstruction conference.

B. At least two weeks prior to commencement of stone column construction, the SPECIALTY SUBCONTRACTOR shall submit for review by the ENGINEER five copies of a stone column installation plan, shop drawings describing the equipment and materials, details and dimensions, including, but not limited to: a description of downhole vibrator; stone backfill material; spacing, location, length, and top and toe elevation of stone columns; and techniques to be employed by the stone column construction. The stone column shop drawing shall address any potential effects of ground treatment effort on adjacent structures or utilities.

C. Submit for review by the ENGINEER five copies of design calculations demonstrating that the stone column design will meet the specified design requirements.

D. Submit for review the format for recording and maintaining both field and final records as specified herein.

E. Submit a minimum 50 pound sample of the stone backfill and certificate of conformance from the stone backfill supplier. The material will be sampled at the source by the ENGINEER to determine compliance with specification. The stone backfill material shall be brought to the site only after stone backfill sources have been approved in writing by the ENGINEER.

F. As-built survey drawings shall be prepared by the CONTRACTOR after completion of stone columns at each structure and submitted to the ENGINEER before construction of any foundations.

G. Daily field records of the stone column installation shall be made by the SPECIALTY CONTRACTOR. Daily field logs shall include: recording of stone column reference number, start/finish time to create hole and time to form each stone column, top and toe elevation of stone column, stone backfill quantities, and indication of relative amp meter increases. Submit daily field records at end of each day of ground modification and final results to the ENGINEER within 15 calendar days after successful completion of the stone column installation at each building location.

H. A detailed safety plan is required to verify that job site personnel, off-site personnel, and adjacent properties are protected. The safety plan will address the proposed barriers, fences, etc. to be utilized in protecting off-site personnel. The safety plan will include, but not be limited to, daily, weekly, and monthly maintenance program of equipment.

1.9 QUALITY ASSURANCE

A. All stone column work shall be done by the SPECIALIZED SUBCONTRACTOR.

B. CPT verification testing will be conducted by the CITY both during and after the stone column installation to verify effectiveness of the stone columns. The CONTRACTOR shall grade areas to allow access for the truck-mounted drill and CPT rigs.

C. Where critical structures or facilities exist adjacent to areas of proposed stone column installations, the Contractor shall establish settlement monitoring reference points in locations approved by the Engineer. Surface settlement points located on pavement shall either be pk nails or paint marks. Surface settlement points located on soil shall be 2”x2” wooden hubs with a nail in the top. The ENGINEER will monitor the reference points within 48 hours before ground improvement work, daily after ground improvements start, and once within 48 hours after ground improvements are completed and perform vibration testing at adjacent structures when necessary.

D. The responsibility for conducting the stone column installation in a manner which will protect adjacent structures and facilities rests solely with the CONTRACTOR. The cost of repairing any damage to adjacent structures and restoration of facilities shall be the responsibility of the CONTRACTOR.

PART 2 PRODUCTS

2.1 EQUIPMENT

A. The Specialty Contractor shall use machines or combinations of machines and equipment that are in good safe working condition and that will produce the results specified herein.

B. Down-hole Vibrating probe:

1. Down-hole vibrating probe shall be capable of providing at least 80 horsepower and 15 tons of force.

2. The probe and follower shall be of sufficient length to reach the specific elevations.

3. The probe shall be capable of penetrating to the specified toe elevation.

4. The probe and followers shall have visible external markings at one foot increments to enable measurement of penetration and re-penetration.

C. Stone Backfill: The stone backfill for stone column construction shall be clean, hard crushed stone, free from organics, trash, or other deleterious materials. The crushed stone shall meet the following gradation requirements (in accordance with ASTM D2487) and quality requirements.

Sieve Size	Percent Passing by Dry Weight
2-inch	100
1-inch	90-100
½-inch	5-80
No. 4	0-5

Test	Test Method	% Weight Los
Soundness	ASTM C88	15% Max.
Durability Index	Caltrans California Test 229	40
Degradation	ASTM C131	45% max. @ 5,000 rev

PART 3 EXECUTION

3.1 SITE PREPARATION AND PRE-GROUND IMPROVEMENT GRADING

A. Site preparation and pre-ground improvement grading required to create a working platform shall be done in accordance with Section 02100, Site Preparation, and Section 02200, Earthwork, shall be completed prior to commencement of stone column work.

3.2 RECORD KEEPING

A. The Specialty Contractor shall keep complete and accurate daily field records of the stone column operations.

3.3 STONE COLUMN CONSTRUCTION

A. The vibrating probe shall penetrate the ground, by its own weight until it reaches the design treatment depth. Predrilling of stiff lenses, layers, or strata is permitted.

B. The construction technique shall produce approximately circular holes. Sufficient jetting shall be provided to the probe tip to widen the probe hole to a diameter of 12 inches greater than the probe diameter to allow adequate space for backfill placement around the probe. (Note is not applicable to center feed probes.)

C. The stability of the probe hole shall be maintained at all times to prevent caving or collapse of the hole and to form a clean stone column.

D. The vibrator shall slowly be retrieved in the design increments to allow stone backfill placement.

E. The vibrator should be re-driven through each increment of recently treated depth interval to observe and record amperage buildup increase.

F. Stone columns shall be installed so that each completed stone column will be continuous throughout its length.

3.4 TOLERANCES

A. Location: No vibration center or stone column shall be more than 4 inches off its correct center location shown on the approved plan, except when an obstruction is encountered.

B. The axis of the stone column shall not be included from vertical by more than 2 inches in 10 feet as indicated by the tilt of the probe and followers.

C. If the stone columns do not meet the above requirements, then the installation operation must be adjusted to produce the required ground improvement criteria or, if approved by the ENGINEER, the stone column spacing decreased at the SPECIALIST CONTRACTOR's expense to give the same percentage of area improved with stone column.

3.5 CLEAN-UP

A. Erosion depressions caused by stone column construction shall be backfilled with engineered fill as specified in Section 02200.

B. If the upper soil layer is loosened during stone column construction, the loosened soils shall be scarified and recompacted as engineered fill as specified in Section 02200. If the loosened surface layer exceeds 18 inches, the loose soil should be overexcavated and backfilled with engineered fill as specified in Section 02200.

C. The working surface shall be cleaned at the completion of stone column construction of all unsuitable materials washed up from the stone column holes. Such unsuitable materials include clay or silt, wood fragments, or other organic materials. The unsuitable materials shall be disposed of in a manner approved by the ENGINEER.

END OF SECTION

SECTION 02256 – JET GROUTING

PART 1 GENERAL

1.1 THE REQUIREMENT

A. Where ground improvement is required in areas containing and in proximity to existing structures, piping and underground utilities, and damaging ground vibrations from stone columns as specified in Section 02555 are anticipated, an alternative ground improvement technique, such as jet grouting, shall be employed. Jet grouting shall be used

B. The work shall be performed by a SPECIALTY SUBCONTRACTOR who can meet the design requirements as outlined below. The SPECIALTY SUBCONTRACTOR shall coordinate his work with the CONTRACTOR.

C. The SPECIALTY SUBCONTRACTOR shall provide all engineering, supervision, labor, materials, equipment, and related services necessary to densify the liquefiable sands and silty sand and structurally reinforce the more cohesive soils (i.e., silts and clays) by improving the soil with the construction of jet grout columns in the areas shown on Sheet G-13 of the Contract Drawings and to the elevations and design criteria specified herein.

D. The work shall include the following:

1. The SPECIALTY SUBCONTRACTOR shall be responsible for preparing a ground improvement design to achieve the liquefaction mitigation and foundation support criteria described herein and in the Contract Documents referenced herein. The design shall be reviewed and approved by the Engineer.

2. Furnishing all materials, including cement mix, for the jet grout columns.

3. Construction of the jet grout columns including layout work.

4. Furnishing equipment, electrical power, water and any other necessary items for the jet grout column construction.

5. Control and disposal of water (surface and subsurface byproduct water) resulting from the jet grout construction.

6. Construction of working pad necessary for the jet grout column construction.

7. Construction and removal of mixing ponds (or similar) as required, and the regrading of site areas disturbed by the jet grout column construction.

8. Stockpiling and disposal of clay, silt, and organic materials washed up from jet grout column construction, if necessary.

9. Maintaining daily field records as specified.

1.2 RELATED WORK SPECIFIED ELSEWHERE

A. Section 02100 - Site Preparation

B. Section 02140 - Dewatering

C. Section 02200 – Earthwork

D. Section 02255 – Stone Columns

1.3 REFERENCE SPECIFICATIONS, CODES, AND STANDARDS

A. The test methods listed below form a part of this specification to the extent referenced. The publications are referenced to the text by the basic designation American Society for Testing and Materials only (ASTM) and Caltrans Test Methods:

ASTM C150 or AASHTO M85	Portland Cement
ASTM D1633	Standard Test Method for Compressive Strength of Molded Soil-Cement Cylinders
ASTM C109	Standard Test Method for Compressive Strength of Hydraulic Cement Mortars
API Recommended Practice 13B-1	Standard Procedures for Field Testing Water Based Drilling Fluids
ACI 233R C989-99	Slag Cement in Concrete and Mortar, or Standard Specification for Ground Granulated Blast-Furnace Slag for Use in Concrete and Mortars
ASTM D 420	Core Samples, Core Sample Testing Standard Guide to Site Characterization for Engineering, Design, and Construction Purposes.
ASTM D3740	Standard Practice for Minimum Requirements for Agencies Engaged in the Testing and/or Inspection of Soil and Rock as Used in Engineering Design and Construction.
ASTM C618 or AASHTO M295	Standard Specification for Coal Fly Ash and Raw or Calcined Natural Pozzolan for use in Concrete
AASHTO T26 ASTM C1602/C 1602M	Water Testing of Non-Potable Water, or Standard Specification for Mixing Water Used in the Production of Hydraulic Cement Concrete.
ASTM D1586	Standard Test Method for Penetration Test and Split-Barrel Sampling of Soils
ASTM D2487	Standard Practice for Classification of Soils for Engineering Purposes (Unified Soil Classification System).

ASTM D5778	Standard Test Method for Performing Electronic Friction Cone and Piezocone Penetration Testing of Soil

1.4 DEFINITIONS AND ABBREVIATIONS

A. Definitions:

Jet Grouting: An in-situ injection technique employed with specialized equipment that includes grout pump(s), grout mixer, drill rig, drill rods and injection monitor with horizontal radial nozzles delivering high velocity fluids to erode, mix, and stabilize in-situ soils using an engineered grout slurry.

Jet grout columns: A narrow vertical column of grout stabilized soil of specified width, created by rotating the drill pipe during the jet grouting process, interconnected with adjacent columns to form stabilized trench walls, trench bottom bracing, and groundwater control.

Single Fluid Jet Grouting: The jet grouting technique where a single fluid, typically neat cement grout, is injected at high velocity through horizontal radial nozzle(s) to directly erode, and mix with, the in-situ soil.

Double Fluid Jet Grouting: The jet grouting technique where one fluid, typically neat cement grout, is injected at high velocity through horizontal radial nozzle(s) and is assisted by a second fluid, typically air, delivered through a coaxial nozzle(s), to directly erode and mix with the in-situ soil.

Triple Fluid Jet Grouting: The jet grouting technique where one fluid, typically water, is injected at high velocity through horizontal radial nozzle(s) and is assisted by a second fluid, typically air delivered through a coaxial nozzle(s), to erode the in-situ soil, while a separate nozzle placed lower on the monitor delivers a third fluid, typically neat cement grout, at lower velocity to simultaneously fill the soil zone eroded by the cutting fluids (air and water).

Monitor (adjusted for single, double, and triple systems): A single, double, or triple fluid drill pipe attached to the end of a drilling string and designed to deliver one to three elements of the Jet Grouting process, typically air, water, and grout. The monitor has one or more injection points (nozzles).

Jet Grouting Supervisor: The individual on site who is in responsible charge for the jet grouting work.

Soil-cement: Mixture of grout slurry and in situ soils formed by the jet grouting process.

Soil-cement element: A column, or panel (planar shape), of soil-cement formed by jet grouting, used as a component of a soil-cement structure.

Soil-cement structure: A single zone or block of jet grout elements that are partially or fully interlocked as indicated on the Contract Drawings. Soil cement structures shall be comprised of soil cement elements of sufficient pattern and spacing as to stabilize the soil mass within the limits shown on the Contract Drawings to meet the performance requirements specified in this Section.

Jet Grouting Parameters: Pressure of the fluid(s) within the jet grouting string; flow rate of the fluid(s); grout composition; rotational speed of the jet grouting string; and rate of withdrawal or insertion of the jet grouting string.

Jet Grouting String: Jointed rods with simple, double or triple inner conduit that conveys the jet grouting fluid(s) to the monitor.

Spoil Return: All materials including, but not limited to: liquids, semi-solids, and solids, which are discharged above ground surface during, or as a result of jet grouting.

B. Abbreviations

1. CPT: Cone Penetration Test

2. $(N_1)_{60cs}$: Equivalent clean sand normalized SPT blow count

3. SPT: Standard Penetration Test

4. $(Q_{c1N})_{cs}$: Equivalent clean sand normalized CPT penetration resistance

1.5 SUBSURFACE CONDITIONS

A. A geotechnical report has been prepared for this project, including subsurface borings, cone penetration testing (CPTs), laboratory testing, and review of previous investigations. The report is entitled "Geotechnical Investigation Report, Brentwood Wastewater Treatment Plant Expansion Project, Brentwood, California", dated September 12, 2017, prepared by Cal Engineering & Geology, Inc. An addendum to the Geotechnical Investigation Report was issued on February 27, 2018.

A geotechnical report has been prepared for the 2001/2002 plant expansion, including subsurface borings, cone penetration testing (CPTs), test pits, shallow excavations, and laboratory testing. The report is entitled "Geotechnical Engineering Investigation Report, City of Brentwood, Brentwood Wastewater Treatment Plant Expansion Project, Brentwood, California", dated January 2000, prepared by DCM/Joyal Engineering.

B. The geology at the project site is diverse. In general, the subsurface investigation encountered near-surface deposits consisting of existing fill, sand dune deposits, and clayey deposits. The SPECIALTY CONTRACTOR is responsible for reviewing the available subsurface information pertaining to the site.

1.6 SYSTEM DESCRIPTION

A. The purpose of the subsurface soil improvement program is to reduce the potential for liquefaction, improve bearing capacity, and reduce both static and seismic settlements.

B. Design Requirements: The construction procedures, the specific equipment to be used, and the size and spacing of the jet grout columns shall be determined by the Specialty Contractor to achieve the acceptance criteria specified below in the Tolerance and Acceptance Criteria. Such procedures and related information shall be subject to the approval of the Engineer. However, the following general equipment and construction procedures shall be met.

1. The jet grout columns shall be design to support foundation loads for the structures shown on Sheet G-13 of the Contract Drawings. The limitation of estimated post-liquefaction total and differential settlement shall be 1-inch and ½-inch, respectively.

2. The jet grout columns shall be installed in a grid pattern with a center-to-center spacing of not greater than 10 feet. The area treated with jet grouting shall extend at least 15 feet beyond each building perimeter.

3. The contractor shall use a down-hole vibrator capable of at least 80 HP and 15 tons of force.

4. The contractor shall not use water jets to aid the advance of the vibrator or assist the installation of the jet grout column.

5. After penetration to the full treatment depth, the vibrator shall be slowly retrieved in maximum lifts of 4 ft. increments to allow for backfill placement.

6. The vibrator shall be re-driven through each increment into recently treated depth interval to observe amperage build up in the cohesionless soils.

C. Tolerance and Acceptance Criteria:

1. A grid pattern depicting the placement of the jet grout columns that will provide the desired improvement in the cohesionless soils shall be developed by the Specialty Contractor and reviewed by the Engineer. The spacing should not be wider than 10 feet between the centers of the jet grout columns. The diameter of the jet grout columns should not be less than 2 feet.

2. Settlement Control: Ground surface settlement (or heave) at existing structures, utilities, or other improvements on or adjacent to the site shall be limited to 0.2 inches or less.

3. The CONTRACTOR shall repair any damage resulting from vibrations or surface settlement or heave caused by jet grout column installation.

D. Documentation:

1. Any proposed change in the approved construction program, necessitated by a change in the subsurface conditions, shall be submitted in writing to the Engineer for approval.

2. A daily log shall be submitted to the Engineer by the Specialty Contractor to include probe number, start/finish time of probe, depth of treatment, approximate backfill quantities, and indication of relative amperage readings.

1.7 SPECIALTY SUBCONTRACTOR QUALIFICATIONS

Due to the specialized nature of the jet grouting portion of the work, the Jet Grouting Contractor shall be pre-qualified before bidding on this work. Contractors must meet the following experience criteria;

A. The SPECIALTY SUBCONTRACTOR shall be regularly engaged in ground improvement by jet grouting and shall document that they have performed a minimum of the following work in the United States:

Provided all supervision, labor, material and equipment to have successfully installed jet grout columns on 15 separate projects ranging in depth from 20 to 50 feet. Five of the documented, successfully completed projects shall be similar to this project in type of soil to be improved, dimension of jet grout columns, and equipment type used.

B. The JET GROUTING SUPERVISOR must have at least three (3) years on site experience managing jet grouting field operations of similar size and scope, and must have supervised at least two (2) projects within the past five (5) years employing the jet grouting technique proposed for this project. The supervisor shall have experience and knowledge of all aspects of jet grouting as required for the project and shall be present at the work site at all times during jet grouting operations.

1.8 CONTRACTOR SUBMITTALS

A. Submit qualifications of SPECIALTY SUBCONTRACTOR. CONTRACTOR shall submit SPECIALTY SUBCONTRACTOR's qualifications to the ENGINEER for approval prior to the preconstruction conference.

B. At least two weeks prior to commencement of jet grout column construction, the SPECIALTY SUBCONTRACTOR shall submit for review by the ENGINEER five copies of a jet grout column shop drawings describing the equipment and materials, details and dimensions, including, but not limited to: a description of downhole vibrator; stone backfill material; spacing, location, length, and top and toe elevation of jet grout columns; and techniques to be employed by the jet grout column construction. The jet grout column shop drawing shall address any potential effects of ground treatment effort on adjacent structures or utilities.

C. Submit for review by the ENGINEER five copies of design calculations demonstrating that the jet grouting design will meet the specified design requirements.

D. Submit for review the format for recording and maintaining both field and final records as specified herein.

E. Submit catalog cuts, details of grout mixers, pumps, drill rigs, and a plan view of the jet grout equipment arrangement, noting any equipment that has been modified or is of unique construction.

F. Submit a mix design for the project indicating sources and types of grout materials, with volumetric proportions, and field test data from previous projects or from pre-construction grout material trials indicating set time and compressive strength achieved. If the grouting contractor intends to deviate from the materials defined in this specification, it shall submit, evidence of satisfactory use of the proposed material from past projects with similar soil conditions or pre-construction trials.

G. Submit method for verifying grout mix proportions.

H. Submit a mix design to be used for the jet grouting. The mix design must reference the supplier to determine compliance with specification.

I. Submit details of proposed field demonstration test program for jet grouting, as specified in Section 3.3 of this specification. This shall include location of test columns, layout of test pattern, jet grouting parameters to be used and variables to be tested during test program, and details of proposed quality control/quality assurance testing to meet acceptance criteria specified herein.

J. Following performance of the field demonstration test program and prior to beginning production jet grouting operations, submit details regarding drilling and installation of test columns, jet grouting parameters, quality control/quality assurance test results, and recommended changes to jet grouting parameters based on test program, if any.

K. As-built survey drawings shall be prepared by the CONTRACTOR after completion of jet grout columns at each structure and submitted to the ENGINEER before construction of any foundations.

L. Within one business day of a work shift, submit summary daily reports during test and production jet grouting that provide the information listed below. A sample of the report form proposed for use by the Contractor shall be submitted to the Engineer for approval prior to the start of work.

1. Driller's and helper's names.

2. Jet grout element number.

3. Time and date of beginning and completion of each grout element, including interruptions to the jetting process or material supply.

4. Log of drill cuttings indicating color and texture based on visual observations, elevations of changes in soil type, locations and extent of cavities, soft spots, presence of ground water, and locations drilling fluid losses

5. Grout mix data, including mix proportions and unit weight density measurements.

6. Injection pressure of all fluids used to construct each grout element.

7. Flow rates of all fluids used to construct each grout element.

8. Rates of rotation and withdrawal of jet rods for each grout element.

9. Total grout quantity used for each element.

10. Top and bottom elevations of the jet grout element.

11. Continuous flow of spoils return.

M. Batching reports presenting the following minimum information: date, personnel, weather, mix design, time grout is batched and pumped, receiving column(s), total volume, and remarks.

N. Continuous recording of jet grouting parameters shall be provided for each production column to verify consistency with the approved test program results.

O. Daily field records of the jet grout column installation shall be made by the SPECIALTY CONTRACTOR. Daily field logs shall include: recording of jet grout column reference

number, start/finish time to create hole and time to form each jet grout column, top and toe elevation of jet grout column, stone backfill quantities, and indication of relative amp meter increases. Submit daily field records at end of each day of ground modification and final results to the ENGINEER within 15 calendar days after successful completion of the jet grout column installation at each building location.

P. A detailed safety plan is required to verify that job site personnel, off-site personnel, and adjacent properties are protected. The safety plan will address the proposed barriers, fences, etc. to be utilized in protecting off-site personnel. The safety plan will include, but not be limited to, daily, weekly, and monthly maintenance program of equipment.

1.9 QUALITY ASSURANCE

A. All Jet Grouting shall be performed in the presence of the Owner's QC/QA Representative. Owner's QC/QA representative shall be notified prior to initiating jet grouting. Monitoring and logging of Jet Grouting operations for both test areas and production work shall be performed by the jet grouting contractor.

B. The Contractor's equipment shall be configured to record and continuously show all fluid flows and pressures, rotational speed, depth and rod retraction rates. The rod retraction rate and rod RPM shall be set by the driller then automatically controlled by the drill rig during the entire jet grouting process and recorded on the jet grout installation log.

C. All the data monitored and recorded, as described herein, shall be made available to the Engineer in a format previously agreed on prior to the work. The Contractor shall supply the Engineer with the software used for this task. The software shall be capable of processing the data recorded and graphic in a satisfactory manner. Proposal of the software to be used shall be described in advance to the Engineer.

D. Grout mix proportions shall be measured and documented by the Contractor per the submittal requirements in section 1.5.4 above. Appropriate records shall be kept by the Contractor and submitted to the Engineer to verify that grout mixture(s) are as accepted.

E. Throughout the jet grouting operations, perform continuous coring to full depth on at least 2 percent of production columns to obtain drill cores of the jet grouted soil. The drill core will be evaluated for compliance with specific acceptance criteria defined herein. The contractor shall be notified immediately if the soil-cement samples do not meet the acceptance criteria outlined herein.

F. All jet grout column work shall be done by the SPECIALIZED SUBCONTRACTOR.

G. CPT verification testing will be conducted by the CITY both during and after the jet grout column installation to verify effectiveness of the jet grout columns. The CONTRACTOR shall grade areas to allow access for the truck-mounted drill and CPT rigs.

H. Where critical structures or facilities exist adjacent to areas of proposed jet grout column installations, the Contractor shall establish settlement monitoring reference points in locations approved by the Engineer. Surface settlement points located on pavement shall either be pk nails or paint marks. Surface settlement points located on soil shall be 2"x2" wooden hubs with a nail in the top. The ENGINEER will monitor the reference points within 48 hours before ground improvement work, daily after ground improvements start, and once within 48 hours after ground improvements are completed. .

I. The responsibility for conducting the jet grout column installation in a manner which will protect adjacent structures and facilities rests solely with the CONTRACTOR. The cost of repairing any damage to adjacent structures and restoration of facilities shall be the responsibility of the CONTRACTOR.

PART 2 PRODUCTS

2.1 EQUIPMENT

A. The Specialty Contractor shall use machines or combinations of machines and equipment that are in good safe working condition and that will produce the results specified herein.

B. General: All equipment used for drilling boreholes; lowering, raising and rotating jet monitors; mixing grout; supplying pressurized grout and air-water to jet monitors; and jet monitors shall have proven performance records for use in Jet Grouting work, as demonstrated by the information to be submitted.

C. Drilling Equipment: Use drilling equipment of a type and capacity suitable for drilling required hole diameters and depths, and lowering, raising, and rotating jet grout monitors to the depths and at the rates required to perform the work as shown on the Contract Drawings and as specified herein. The drill rig shall be equipped with automated controls to regulate and maintain consistent rod retraction rate, and rod RPM and have pressure gauges for all fluids injected.

D. Grout Mixing and Injection Equipment: Use grout mixers and holding tanks, water tanks, air compressors, and pumps of sufficient capacity to ensure adequate supply of grout, air, and water at required pressure to the Jet Grouting monitors during a full work shift to produce grout elements of the quality and dimensions necessary.

E. Jet-Grouting pump: Shall be capable, with the nozzles proposed, of providing the required velocity and a delivery rate adequate for the execution of the work.

F. Compressor (for double and triple Jet-Grouting): Shall be capable of producing the pressure and to deliver the flow rate values proposed by the contractor depending on the parameters chosen.

G. Filling grout pump (for triple Jet-Grouting): Shall be capable of producing the pressure and to deliver the flow rate values proposed by the contractor depending on the parameter chosen.

H. Jet Grout Tools: Use Jet Grouting monitors with appropriate nozzles with the capacity suitable for producing jet grout elements in the soil types identified during Subsurface Explorations performed at the site, and of the size and depth shown on the Contract Drawings and as specified herein. The drill hole diameter shall be sufficiently large to be a clear path for continuous spoil return during all jetting operations.

I. Equipment Instrumentation: Provide instrumentation that allows continuous monitoring and automatic recording of data throughout the jet grouting operations. As a minimum, the following shall be provided versus depth:

1. Pressure gauges/devices at the drilling rig to automatically record pressures of cement grout, water, and air during the grouting process.

2. Flow meter(s) to monitor and record the rate and total volume of grouting fluids through the grouting monitor at every element.

3. Devices that automatically monitor and record the rate of monitor rotation and withdrawal

2.2 MATERIALS

The grout slurry may consist of a homogeneous mixture of any of the following materials:

A. Cement, Portland, type I or II, ASTM C-150 or AASHTO M85

B. Ground granulated blast furnace slag per ACI 233R Slag Cement in Concrete and Mortar or C989-99 Standard Specification for Ground Granulated Blast- Furnace Slag for Use in Concrete and Mortars.

C. Flyash Class C or F, ASTM C618 or AASHTO M295.

D. Potable Water or approved other source shall be free of deleterious materials that may adversely affect the grout.

E. Bentonite, if more than 3 percent by weight of cement is used, must be prehydrated for at least 12 hours, unless demonstrated hydration is achieved in less time, prior to being incorporated in the mix.

F. The ratios of the material components shall be proposed by the Contractor, confirmed during the preconstruction test program, and reviewed by the Engineer. Once accepted, grout slurry composition shall not be changed unless requested in writing by the Contractor and accepted in writing by the Engineer

PART 3 EXECUTION

3.1 SITE PREPARATION AND PRE-GROUND IMPROVEMENT GRADING

A. Site preparation and pre-ground improvement grading required to create a working platform shall be done in accordance with Section 02100, Site Preparation, and Section 02200, Earthwork, shall be completed prior to commencement of jet grout column work.

3.2 RECORD KEEPING

A. The Specialty Contractor shall keep complete and accurate daily field records of the jet grout column operations.

3.3 TEST PROGRAM

A. Prior to production work, a test program shall be conducted by the Contractor in accordance with the accepted work plan. The test program shall be used to optimize the various parameters including type of jet-grouting (single, double or triple), necessity of pre-jetting with water, grout mix composition, fluid(s) flows and pressures, rotational speed, retraction rate, grout, and number and size of nozzles; and confirm that resultant in situ soil-cement properties meet required design criteria.

B. The test program and its results will be observed, reviewed and approved by the Engineer. The test program shall be installed in areas near the planned production work at a location agreed upon between the Engineer and jet grouting subcontractor and in representative soils and depths anticipated to be found during production work.

C. Each test section shall consist of a plan of elements suitable to demonstrate feasibility and installed to the same bottom elevation specified for the production jet grouting work.

D. The test columns shall be exposed by excavation (where possible) and measured for geometric properties. If full-depth excavation is not feasible, drill samples or other testing method shall be used to demonstrate column size/geometry. In cases where excavation shall not be possible, a coring in the center of a single column or centroid of a group of three (3) elements shall be carried out, and three acceptable/representative specimens from each column sent to an independent Laboratory for the tests required to satisfy the criteria specified herein. Alternative testing methods may be proposed by the Contractor.

E. Subject to the results of the test program, the jet grouting contractor will present parameters selected to achieve the specified acceptance criteria for review of the Engineer. The Contractor, at their expense, may be required to repeat the construction of a test section if selected parameters fall outside test requirements. The test program shall confirm that the resultant soil-cement properties met the required design criteria prior to the Contractor proceeding with production work.

3.4 JET GROUT COLUMN CONSTRUCTION

A. Execute production jet grouting using the same jet grout tooling, materials, and procedures as demonstrated from the satisfactory set of test elements.

B. Install jet grout columns, such that continuous spoil return up the borehole annulus is achieved during all work.

C. The sequence of the Jet-Grouting, Primary and Secondary, fresh on fresh, pre- jetting with water is the responsibility of the jet grouting contractor and will be based on the results of the successful test program.

D. Maintain a clean site and dispose of all spoil debris, water, and spilled material during jet grouting operations.

E. Equipment for mixing, holding, and pumping grout shall be in a secure location and shall be operated to minimize spillage of material. No material will be allowed to enter storm drains or other drainage courses.

F. The grouting contractor shall monitor nearby grade, structures and utilities during all jetting work.

G. If jet-grouting is interrupted during the execution of a column, the re-start of the jetting shall be undertaken at least 6” below the stopping point.

H. Site access shall be provided to Owner’s representatives for observation of the work.

3.5 ACCEPTANCE CRITERIA

A. Installation records and daily reports documenting that the approved parameters from the test program were accurately repeated for the production work.

B. Grout/Soil Mixture. - A grout mix developed by laboratory tests and field trials shall be prepared by the Contractor in a Work Plan and submitted to the Engineer. The Contractor shall ascertain the compatibility of the ingredients of the mix and their optimum proportions. The grout mixture shall achieve a seven (7) day unconfined compressive strength of 50 psi or greater and a twenty eight (28) day unconfined compressive strength of 200 psi or greater in accordance with ASTM C-109.

C. At least 85 percent of all jet grout samples tested shall have a minimum 28-day unconfined compressive strength of 200 psi.

3.6 TOLERANCES

A. Location: No vibration center or jet grout column shall be more than 4 inches off its correct center location shown on the approved plan, except when an obstruction is encountered.

B. The axis of the jet grout column shall not be included from vertical by more than 2 inches in 10 feet as indicated by the tilt of the probe and followers.

C. If the jet grout columns do not meet the above requirements, then the installation operation must be adjusted to produce the required ground improvement criteria or, if approved by the ENGINEER, the jet grout column spacing decreased at the SPECIALTY CONTRACTOR's expense to give the same percentage of area improved with jet grout column.

3.7 CLEAN-UP

A. Erosion depressions caused by jet grout column construction shall be backfilled with engineered fill as specified in Section 02200.

B. If the upper soil layer is loosened during jet grout column construction, the loosened soils shall be scarified and recompacted as engineered fill as specified in Section 02200. If the loosened surface layer exceeds 18 inches, the loose soil should be overexcavated and backfilled with engineered fill as specified in Section 02200.

C. The working surface shall be cleaned at the completion of jet grout column construction of all unsuitable materials washed up from the jet grout column holes. Such unsuitable materials include clay or silt, wood fragments, or other organic materials. The unsuitable materials shall be disposed of in a manner approved by the ENGINEER.

END OF SECTION

SECTION 02270 – EROSION CONTROL (VEGETATIVE)

PART 1 GENERAL

1.1 THE REQUIREMENT

A. The Contractor shall provide all labor, materials, and equipment for seeding of all disturbed areas on the site not surfaced with other stable materials, including embankment slopes, disturbed areas and areas occupied by the Contractor during construction.

1.2 CONTRACTOR SUBMITTALS

A. The Contractor shall submit the following in accordance with Section 01340 Shop Drawings, Product Data and Samples

1. A signed certification from each source of supply for each material indicating that the material meets the Specification requirements.

PART 2 PRODUCTS

2.1 SEEDING

A. Hydromulch Seeding Mixture: Minimum, 85% germination.

1. Erosion Control Seed Mix: Apply mixture at the rate of 50 pounds per acre. The seed mix shall be as follows:

a.	Blando Brome	20 lbs/acre
b.	Annual Rye Grass	10 lbs/acre
c.	Inoculated Clover	20 lbs/acre

2. Fertilizer: Commercial fertilizer with the following guaranteed chemical analysis:

a.	Nitrogen	16%
b.	Phosphoric Acid	20%
c.	Water Soluble Potash	0%

3. Soil Stabilizing Agent: A mixture of 100% organic, water soluble alginic acids derived from cold water kelps.

4. Fiber: Green colored, fibrous, wood cellulose mulch containing no growth or germination inhibiting factors and manufactured in such a manner that after addition and agitation in slurry tanks with fertilizer, seed, water and other approved additives, the fibers in the material will become uniformly suspended to form a homogenous slurry; and that when hydraulically sprayed on the ground, the material will form a blotter-like ground cover impregnated uniformly with seed; and which after application, will allow the absorption of moisture and allow the rainfall to percolate to the underlying soil.

5. Apply the slurry at the minimum rate of 500 lbs/acre unless otherwise recommended by the manufacturer. Cellulose shall be certified to indicate that

laboratory and field testing of the product has been accomplished and that it meets all of the foregoing requirements based on testing. Weight specifications of this material from suppliers and for all application shall refer only to air dry weight of the fiber material.

6. Absolute air dry weight is based on the normal standards of the Technical Association of the Pulp and Paper Industry for wood cellulose and is considered equivalent to 10% moisture. Each package of the cellulose fiber shall be marked by the manufacturer to show the air dry weight content.

7. Water: Clean potable water shall be added to the slurry mixture in sufficient amount to spread uniformly the required quantity of hydromulch solids (approximately 3,000 gallons per acre).

PART 3 EXECUTION

3.1 SEEDING

A. Preparation of Slopes:

1. Dress and grade the slopes to provide a uniform surface and slope. Loosen the top three inches of compacted fill slopes.

2. Thoroughly water the slopes for one week prior to seeding. Take care not to cause erosion of otherwise damage the slope profile and integrity.

B. Hydromulch Seeding Installation

1. Apply erosion control seed mix at the rate of 50 pounds per acre incorporated with the hydromulch materials and fertilizer as required to all areas indicated.

2. Equipment: Use hydraulic equipment for the application of the fertilizer, seed, and slurry of prepared wood pulp of the type approved by the Engineer. This equipment shall have a built-in agitation system and operating capacity sufficient to agitate, suspend and homogenously mix a slurry containing up to 40 pounds of fiber plus combined total of 70 pounds fertilizer solids for each 100 gallons of water. The slurry distribution lines shall be large enough to prevent stoppage and equipped with a set of hydraulic spray nozzles which will provide a continuous non-fluctuating discharge and delivery of the slurry of the prescribed quantities uniformly, without misses, waste, or erosion. The slurry tank shall have a minimum capacity of 1,000 gallons and be mounted on a traveling unit, which may be either self-propelled or drawn with a separate unit, that will place the slurry tank and spray nozzles within sufficient proximity to the areas to be seeded so as to provide uniform distribution. The Engineer may favorably review equipment with smaller tank capacity provided that the equipment has the necessary agitation system and sufficient pump capacity to spray the slurry in a uniform coat.

C. Preliminary Inspection: Notify the Engineer 48 hours in advance of all seeding. Inspection and favorable review of completed work shall begin the plant establishment period.

D. Plant Establishment Maintenance

1. General plant maintenance shall immediately follow seeding and continue until seeded areas are 85% germinated and covered with acceptable stands of grass and clover.

2. Protect areas against all damage, including erosion and trespass, and provide proper safeguards. Maintain and keep in good repair all temporary barriers erected to prevent trespassing. Check all barrier and temporary fencing daily, and make immediate repairs or replacements

3. Repair all damage to seeded areas.

4. Maintain constant moisture depth in soil to insure vigorous growth.

E. Final Inspection and Acceptance: Final inspection will be conducted upon completion of maintenance, replacements and corrective work. Five (5) days notice shall be given. If project improvements, corrective work, and maintenance have not been performed as specified and to the satisfaction of the Engineer, maintenance shall continue at Contractor's expense until such time as work has been successfully completed.

F. Guarantee and Replacement

1. Guarantee all planting to be in a healthy, thriving condition until the end of the maintenance period or beyond that time until active growth is evident and for one year from date of acceptance.

2. Replace all seeded areas not in vigorous condition as soon as directed by Engineer. Seed mixture used for replacement must be of the same kind and quantity as specified in this section.

G. Timing of Erosion Control Application: Application of hydromulch and seed shall occur after the first significant rainfall of the season in the late Fall and no later than February in any year to better ensure establishment of the vegetation.

END OF SECTION

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SECTION 02390 – SHORING

PART 1 GENERAL

1.1 THE REQUIREMENT

A. The Work specified in this Section includes shoring systems for the support of excavations including, but not limited to, trench and structure excavations. Shoring shall also be required for excavation near existing structures. The Contractor shall furnish, install, and remove upon completion of the required construction, unless shown otherwise, all systems of supports, including all bracing and associated items to retain the sides of the excavations. The Contractor shall be responsible for the selection of methods, the design, construction and removal of all shoring systems. Shoring shall be required unless otherwise approved by the Engineer.

B. The provisions specified hereunder shall be understood:

1. To complement, and not to substitute or diminish, the obligations of the Contractor for the furnishing of a safe place of work pursuant to the provisions of the Occupational Safety and Health Act of 1970 and its subsequent amendments and regulations and for the protection of the Work, structures, and other improvements.

2. To represent a minimum requirement for:

   a. The number and types of means needed to maintain soil stability.
   b. The strength of such required means.
   c. The methods and frequency of maintenance and observation of the means used for maintaining soil stability.

C. Excavation support shall include sheeting, shoring, bracing, and other means and procedures required to maintain the stability of soils.

D. The Contractor shall provide excavation support in trenches for the protection of workers from the hazard of caving ground. Excavation supports shall be provided:

1. Where, as a result of excavation work and an analysis performed pursuant to general engineering design practice.

2. The excavated face or surrounding soil mass may be subject to slides, caving, or other type of failure.

3. The stability and integrity of existing structures and other improvements may be compromised by settlement or shifting of soils.

E. Whatever shoring system is used, the shoring and dewatering system should together meet all of the following minimum requirements:

1. Provide stable excavation walls and bottom

2. Provide reasonably dry base of excavation

3. Filter native soil and prevent loss of ground through piping

4. Prevent hydrostatic uplift pressure during construction and prevent piping (boiling), and/or heave of the excavation bottom

5. Where shoring is not designed to resist hydrostatic pressures, draw down the groundwater level below and beyond the excavation sidewalls.

6. Protect adjacent existing utilities, pipelines, and structures.

7. Installation of support system should not cause settlement or heave of the ground surface nor produce construction vibrations that could damage adjacent utilities or structures.

8. Prevent running, caving and sloughing of excavation walls and associated loss of adjacent utilities or structures.

9. Resist lateral earth pressures, hydrostatic pressures lateral loads from traffic, construction equipment, and spoils.

10. Allow for the removal of shoring in a manner that does not damage structures (new and existing), adjacent utilities, and the pipeline and does not cause settlement of heave of the structure pipeline or settlement or heave of the ground surface, not produce construction vibrations that could damage adjacent utilities, pipelines, or structures.

F. The Contractor's dewatering and shoring submittal should contain alternative (i.e., contingent) systems, and the Contractor should be prepared to alter initial dewatering systems and/or implement alternative dewatering and shoring systems should the initial systems not achieve the above minimum requirements.

G. Where shoring is not designed to resist hydrostatic pressures and dewatering systems need to be designed to draw down the groundwater level below the excavation bottom and below and beyond the excavation sidewalls. Piezometers (i.e., monitoring wells) should be installed adjacent to the excavation to monitor the groundwater levels prior to and while the excavation is open. The purpose of the piezometers is to confirm that the groundwater level is adequately lowered prior to and during excavation and shoring installation.

H. Groundwater dewatering wells, well points, and piezometers should be installed and removed in accordance with local requirements.

1.2 RELATED WORK SPECIFIED ELSEWHERE

A. Section 02140 - Dewatering

B. Section 02200 - Earthwork

1.3 REFERENCE SPECIFICATIONS, CODES, AND STANDARDS

A. Without limiting the generality of other requirements of these Specifications, all work specified herein shall conform to or exceed the requirements of the Building Code and the applicable requirements of the following documents to the extent that the provisions of such documents are not in conflict with the requirements of this Section; provided, that for Building Codes, the latest edition of the code, as adopted as of the date of award by the agency having jurisdiction, shall apply to the Work.

B. Reference codes, regulations, specifications and standards include, but are not limited to:

1. California Labor Code

2. Occupational Safety and Health Administrative Code

3. Uniform Building Code (UBC)

4. Manual of Steel Construction, AISC, 9th Edition

C. The Contractor's attention is directed to the provisions for "Shoring and Bracing Drawings" in Section 6705 of the California Labor Code. The Contractor, prior to beginning any trench excavation exceeding 5 feet in depth, shall submit to the Engineer and shall be in receipt of the Engineer's written acceptance of the Contractor's detailed plan showing design of all shoring, bracing, sloping of the sides of excavation, or other provisions for worker protection against the hazard of caving ground during the excavation. Plans shall be prepared and sealed by a Civil or Structural Engineer registered in the State of California.

D. In preparing these Contract Documents, the Engineer has relied upon the following geotechnical work:

1. A Geotechnical Report has been prepared for this project. The report is entitled "Geotechnical Report – Brentwood Wastewater Treatment Plant Expansion Project," September 12, 2017. An addendum to the Geotechnical Investigation Report was issued on February 27, 2018.

2. The geotechnical information is separately available.

3. The Contractor must be aware of the subsurface conditions which will affect shoring, as well as dewatering. Excavations which extend below the groundwater will require dewatering. Refer to Section 02140 – Dewatering, for project specifications.

1.4 DESIGN CRITERIA

A. General. In all areas, the shoring system, including all the components, shall be designed by the Contractor to support earth and rock pressure, unrelieved hydrostatic pressures, utility loads, equipment, applicable traffic and construction loads, and other surcharge loads in such manner as will allow the safe and expeditious construction of the permanent structures without movement or settlement of the ground and will prevent damage to or movement of adjacent structures and utilities.

B. It is the Contractor's responsibility to review the existing underground utilities, to make his/her own interpretation regarding the ground conditions from previous reports and boring, and to make any other additional surveys and/or borings he/she believes are necessary to determine the types and extent of bracing and shoring systems required to accomplish the Work. All of the foregoing costs shall be included in the Contractor's total price for performing the Work.

1.5 SUBMITTALS

A. Shoring submittal. The Contractor shall submit shoring submittal including shop drawings and supporting calculations of excavation support systems. The shop

drawings shall be prepared and sealed by a Civil or Structural Engineer registered in the State of California. The submittal requirements include:

1. Shop drawings to scale;

2. The shoring submittal shall include the construction method to be used for the installation of the shoring, equipment descriptions, and the sequence of installation and removal of shoring;

3. Shop drawings and design load assumptions and calculations indicating arrangement of supports and construction sequence for proposed support systems(s);

4. Show the elevation of struts, braces, or other supports as related to the depth of excavation at intermediate stages of construction;

5. Provide details of working base, drains, and sump construction;

6. Indicate sizes, shapes, and material specifications for all support elements including lagging, if used; and

7. Calculations shall include estimates of likely deflections or deformations of the support system and maximum tolerable values.

B. All expenses incurred in performing the Work described in this Section shall be borne by the Contractor.

C. The review of the Contractor's shoring plans and methods of construction by the Owner or his representatives does not relieve the Contractor of the responsibility to provide and maintain an adequate and safe support system achieving the specified requirements.

PART 2 PRODUCTS

2.1 MATERIALS

A. All timber and structural steel used for the supporting system, whether new or used, shall be sound and free from defects which may impair their strength.

B. Sheet piling shall be of an internally braced continuous interlocking type forming a continuous wall. Sheet piling and all accessories shall conform to the requirements of ASTM Designation A328.

C. Structural steel members shall be designed in accordance with the Manual of Steel Construction. Timber members shall be designed in accordance with the latest edition of the Uniform Building Code.

PART 3 EXECUTION

3.1 STEEL SHEET PILING

A. The Contractor shall drive sheet piling in plumb position with each pile interlocked with adjoining piles for its entire length including corners so as to form a continuous

diaphragm throughout the length of each run of wall and at each wall corner, bearing tightly against original ground.

B. The sheet piling shall be driven to the depth indicated on the shop drawings, with a minimum depth of 10 feet below the bottom of the trench, or the excavation bottom.

C. The Contractor shall exercise care in driving to avoid damage to existing utilities so that interlocking members can be subsequently extracted without injury to adjacent fills or existing utilities.

3.2 INTERNAL BRACING SUPPORT SYSTEM

A. The Contractor shall provide internal bracing support system including lagging and sheeting, sheet piles, wales, struts, and/or shores.

B. The Contractor shall install and maintain all bracing support members in tight contact with each other and with the surface being supported. Support system monitoring provisions shall be installed as indicated on the approved shop drawings.

C. If necessary to control shoring movement, the Contractor shall preload bracing members by jacking struts to 50 percent of the design load. Preload bracing members shall be loaded in accordance with methods, procedures, and sequence as described on the approved shop drawings. Excavation work shall be coordinated with the installation of bracing and preloading. Steel shims and steel wedges welded or bolted in place to maintain the preloading force shall be used in the bracing after release of the jacking equipment pressure.

D. Excavation shall proceed to no more than two feet below point of the support about to be placed. The support shall be installed and preloaded immediately after installation and prior to continuing excavation.

3.3 REMOVAL OF SUPPORTING SYSTEM

A. The Contractor shall remove all shoring, including sheet piles, wales, struts, lagging and shores from the excavation. Removal of the supporting system shall be performed in a manner that will avoid damage of adjacent construction or facilities. All voids created by the removal of the supporting system shall be immediately filled with well-graded cohesionless sand, lean concrete, or sand cement grout.

END OF SECTION

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SECTION 02460 – ASPHALT CONCRETE PAVEMENT AND BASE

PART 1 GENERAL

1.1 THE REQUIREMENT

A. The Contractor shall perform all work associated with Asphalt Concrete (A.C.) Pavement and Base as shown and as specified herein including all labor, materials, equipment supplies, and facilities associated with providing a finished product satisfying all the requirements of the Contract Documents.

1.2 REFERENCE SPECIFICATIONS, CODES, AND STANDARDS

AASHTO M 82	Cut-Back Asphalt (Medium Curing Type)
AASHTO M 140	Emulsified Asphalt
AASHTO M 208	Cationic Emulsified Asphalt
AASHTO M 226	Viscosity Graded Asphalt Cement
AASHTO MP 1	Performance Graded Asphalt Binders
ASTM D 242	Mineral Filler for Bituminous Paving Mixtures
ASTM D 692	Coarse Aggregate for Bituminous Paving Mixtures
ASTM D 977	Emulsified Asphalt
ASTM D 1073	Fine Aggregate for Bituminous Paving Mixtures
ASTM D 1188	Bulk Specific Gravity and Density of Compacted Bituminous Mixtures Using Paraffin-Coated Specimens
ASTM D 1557	Moisture-Density Relations of Soils and Soil - Aggregate Mixtures Using 10-lb (4.54-kg) Rammer and 18-in (45-mm) Drop7
ASTM D 2027	Cutback Asphalt (Medium Curing Type)
ASTM D 2397	Cationic Emulsified Asphalt
STM D 2726	Bulk Specific Gravity and Density of Compacted Bituminous Mixtures using Saturated Surface-Dry Specimens.
ASTM D 3381	Viscosity-Graded Asphalt Cement for Use in Pavement Construction
ASTM D 3515	Hot-Mixed, Hot-Laid Bituminous Paving Mixtures.

State of California Department of Transportation (CalTrans) Standard Specifications

1.3 CONTRACTOR SUBMITTALS

A. The Contractor shall submit, in writing, materials testing reports, job-mix formulas and other pertinent information satisfactory to the Engineer demonstrating that materials and methods Contractor proposes to utilize will comply with the provisions of this Section. Submittals shall be in accordance with Section 01340 – Shop Drawings, Product Data and Samples.

B. Suitability Tests of Proposed Materials: Tests for conformance with the Specifications shall be performed prior to start of the Work. The samples shall be identified to show the name of the material, aggregate source, name of the supplier, contract number, and the segment of the Work where the material represented by the sample is to be used. Results of all tests shall be submitted to the Engineer for approval. Materials to be tested shall include aggregate base, coarse and fine aggregate for paving mixtures, mineral filler, and asphalt cement.

C. Trial Batch: Before placing any paving material, a testing laboratory acceptable to the Engineer shall prepare a trial batch of asphalt concrete for each job-mix formula to be used by the Contractor for the work. The trial batch shall be prepared using the aggregates and asphalt cement proposed by the Contractor, and approved by the Engineer. The compacted trial batch shall provide a basis for computing the voids ratio, provide an indication of the optimum asphalt content, and establish a basis for controlling compaction during construction. The cost of not more than two laboratory trial batch tests will be borne by the Owner but the Contractor shall furnish the materials at no cost. Any additional trial batch testing required shall be performed at the expense of the Contractor.

PART 2 PRODUCTS

2.1 AGGREGATE BASE

A. Materials for aggregate base shall be Class 2 Aggregate Base as specified in Section 02200 – Earthwork.

2.2 PRIME COAT

A. Prime coat shall be Grade SC-250 liquid asphalt complying with the requirements of AASHTO M 82 (ASTM D 2027). Grade SC-70 liquid asphalt may be used when acceptable to the Engineer.

2.3 TACK COAT

A. Tack coat shall be emulsified asphalt Grade SS-1 or SS-1h, CSS-1 or CSS-1h diluted with one part water to one part emulsified asphalt, undiluted asphalt Grade RS-1 or CRS-1, or paving asphalt Grade AR-1000. Emulsified asphalt shall comply with the requirements of AASHTO M 140 (ASTM D 977) or M 208 (ASTM D 2397); paving asphalt shall comply with the requirements of AASHTO M 226 (ASTM D 3381).

2.4 ASPHALT CEMENT

A. Asphalt Cement shall be Grade AR-8000 complying with the requirements of AASHTO M226 (ASTM D 3381).

2.5 MINERAL AGGREGATE

A. Mineral aggregate shall be crushed stone, crushed slag, crushed gravel, stone or slag screening, sand, mineral filler, or a combination of two or more of these materials. Coarse and fine aggregates shall comply with all the quality requirements, except soundness, of ASTM D 692 and D 1073, respectively. Coarse aggregate failing to comply with abrasion requirements may be used if experience has demonstrated it to be satisfactory.

B. Mineral filler shall comply with ASTM D 242.

C. Combinations of aggregates having a history of polishing shall not be used in surface courses.

2.6 ASPHALT-AGGREGATE MIXTURE

A. Base and Surface Course Mixture: The Contractor shall submit for approval a job-mix formula for each mixture. The job-mix formula for the asphalt-aggregate base and surface course mixture shall confirm to the requirements of the CalTrans Standard Specifications, Section 39, for Type B asphalt concrete, 19 mm (3/4 inches) medium. The asphalt binder to be used shall be PG 64-10 as specified by AASHTO MP-1. No more than 15% reclaimed asphalt pavement (RAP) is allowed for asphalt mixtures.

2.7 PAVEMENT MARKING PAINT

A. Pavement marking paint, where indicated on drawings, shall be a product specifically formulated for use on asphalt concrete pavement and shall have a proven record of performance and durability.

B. In areas to be slurry sealed, all existing pavement markings, stripings, etc. shall be replaced in kind after slurry seal application is complete.

2.8 SLURRY SEAL

A. Caltrans Type II (two) slurry seal shall be installed as shown on the Contract Documents. Asphalt emulsion shall be grade SS-1 or SS-1h, or Grade CSS-1 or CSS-1h complying with the requirements of AASHTO M 140 (ASTM D 977). Aggregate shall consist of rock dust and plaster sand or other sands of similar nature, except that an aggregate or combination of aggregates shall contain not less than 50 percent of the product obtained by crushing rock. The material shall be free from vegetable matter and other deleterious substances. Asphalt emulsion shall be added at a rate of 11 to 25 percent weight of the dry aggregate.

2.9 SOIL STERILANT

A. Soil sterilant or chemical weed control agent shall be a commercial product manufactured specifically to sterilize the subgrade soil to prevent the growth of weeds, plants or any type of vegetation.

T 3 **PART 3 EXECUTION**

3.1 SUBGRADE PREPARATION

A. The subgrade shall be prepared as specified in the Section 02200 – Earthwork as applicable to roadways and embankments. The surface of the subgrade after compaction shall be hard, uniform, smooth and true to grade and cross-section.

Subgrade for pavement shall not vary more than 0.02-foot from the specified grade and cross section. Subgrade for base material shall not vary more than 0.04-foot from the specified grade and cross section. Apply soil sterilant or chemical weed control agent to all subgrade below asphalt-concrete paved surfaces in strict compliance with manufacturer's dosages and application instructions, and any applicable laws, ordinances or regulations governing the use of such chemicals.

3.2 AGGREGATE BASE

A. Aggregate base shall be provided where shown and to the thickness shown. Imported aggregate bases shall be delivered to the job site as uniform mixtures and each layer shall be spread in one operation. Segregation shall be avoided and the base shall be free of pockets of coarse or fine material. Where the required thickness is 6 inches or less, the base materials may be spread and compacted in one layer. Where the required thickness is more than 6 inches the base material shall be spread and compacted in two or more layers of approximately equal thickness and the maximum compacted thickness of any one layer shall not exceed 6 inches. The relative compaction of each layer of aggregate base shall be not less than 95 percent of maximum density when measured in accordance with ASTM D 1557. The compacted surface of the finished aggregate shall be hard, uniform, smooth and at any point shall not vary more than 0.02 foot from the specified grade or cross-section.

3.3 PRIME COAT

A. Prior to placing of pavement a prime coat of cutback asphalt shall be applied to the compacted base or subgrade at a rate between 0.10 and 0.25 gal/sq yd.

3.4 TACK COAT

A. A tack coat shall be applied to existing paved surfaces where new asphalt concrete is to be placed on existing pavement. It shall also be applied to the contact surfaces of all cold pavement joints, curbs, gutters, manholes and the like immediately before the adjoining asphalt pavement is placed. Care shall be taken to prevent the application of tack coat material to surfaces that will not be in contact with the new asphalt concrete pavement. Diluted emulsified asphalt shall be applied at the rate of 0.05 to 0.15 gal/sq yd. Undiluted emulsified asphalt shall be applied at the rate of 0.025 to 0.075 gal/sq yd. Paving asphalt shall be applied at the rate of approximately 0.05 gal/sq yd.

3.5 ASPHALT CONCRETE

A. At the time of delivery to the Work site, the temperature of mixture shall not be lower than 260 degrees F or higher than 320 degrees F, the lower limit to be approached in warm weather and the higher in cold weather.

B. Asphalt concrete shall not be placed when the atmospheric temperature is below 40 degrees F or during unsuitable weather.

C. The asphalt concrete shall be evenly spread upon the subgrade or base to such a depth that, after rolling, it will be of the specified cross section and grade of the course being constructed.

D. The depositing, distributing, and spreading of the asphalt concrete shall be accomplished in a single, continuous operation by means of a self-propelled mechanical spreading and finishing machine designed specially for that purpose. The machine

shall be equipped with a screed or strike-off assembly capable of being accurately regulated and adjusted to distribute a layer of the material to a definite pre-determined thickness. When paving is of a size or in a location that use of a self-propelled machine is impractical the Engineer may waive the self-propelled requirement.

E. Spreading, once commenced, must be continued without interruption.

F. The mix shall be compacted immediately after placing. Initial rolling with a steel-wheeled tandem roller, steel three-wheeled roller, vibratory roller, or a pneumatic-tired roller shall follow the paver as closely as possible. If needed, intermediate rolling with a pneumatic-tired roller shall be done immediately behind the initial rolling. Final rolling shall eliminate marks from previous rolling. In areas too small for the roller a vibrating plate compactor or a hand tamper shall be used to achieve thorough compaction.

G. Upon completion the pavement shall be true to grade and cross-section. When a 10-ft straightedge is laid on the finished surface parallel to the center of the roadway, the surface shall not vary from the edge of the straightedge more than 1/8-in except at intersections or changes of grade. In the transverse direction, the surface shall not vary from the edge of the straightedge more than 1/4-in.

H. The relative density after compaction shall be 95 percent of the density obtained by using ASTM D 1188 or D 2726. A properly calibrated nuclear asphalt testing device shall be used for determining the field density of compacted asphalt concrete, or slabs or cores may be laboratory tested in accordance with ASTM D 1188.

3.6 PAVEMENT MARKING

A. Pavement marking paint shall be applied where shown only when the pavement surface is dry and clear and when the air temperature is above 40 degrees F, and after finale pavement or slurry seal surfacing has been completed. All equipment used in the application of pavement marking shall produce stripes and markings of uniform quality with clean and well defined edges that conform to the details and dimensions shown. Drips, overspray, improper markings and paint material tracked by traffic shall be immediately removed from the pavement surface by methods previously reviewed by the Engineer.

B. In areas to be slurry sealed, all existing pavement markings, stripings, etc. shall be replaced in kind after slurry seal application is complete.

3.7 SLURRY SEAL

A. A slurry seal shall be applied to the surfaces of existing pavement and new pavement as shown on the Contract Documents. Before placing slurry seal the pavement shall be cleaned by sweeping, flushing or other means necessary to remove all loose particles of paving, dirt and other extraneous material. Slurry seal shall not be placed when the atmospheric temperature is below 65 degrees F, or during unsuitable weather. The slurry mixture shall be uniformly spread by means of a controlled spreader box. Slurry mixture to be spread in areas inaccessible to the controlled spreader box may be spread by other approved methods. Slurry seal shall be spread at a rate of 15 pounds of dry aggregate per square yard. Ridges or bumps in the finished surface will not be permitted. The mixture shall be uniform and homogeneous after spreading and shall not shown separation of the emulsion and the aggregate after setting.

END OF SECTION

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SECTION 02500 – BURIED PIPE INSTALLATION

PART 1 GENERAL

1.1 THE REQUIREMENT

A. The Contractor shall furnish and install all buried yard piping and related appurtenances including connections to existing and new structures in accordance with the requirements of the Contract Documents.

B. Work specified under this section shall also conform to pipe material specifications found in Division 2 – Sitework and Division 15 – Mechanical.

1.2 REFERENCE SPECIFICATIONS, CODES, AND STANDARDS

A. Codes: All work specified herein shall conform to the requirements of all applicable codes and regulations.

B. Commercial Standards:

ASTM A193	Standard Specification for Alloy-Steel and Stainless Steel Bolting for High Temperature or High Pressure Service and Other Special Purpose Applications
ASTM A194	Standard Specification for Carbon and Alloy Steel Nuts for Bolts for High Pressure or High Temperature Service, or Both
ASTM B8	Standard Specification for Concentric-Lay-Stranded Copper Conductors, Hard, Medium-Hard, or Soft
ASTM D1351	Standard Specification for Thermoplastic Polyethylene Insulation for Electrical Wire and Cable

1.3 CONTRACTOR SUBMITTALS

A. Shop Drawings: The Contractor shall submit shop drawings and laying diagrams of pipe and fittings in accordance with the requirements of Section 01340 – Shop Drawings, Product Data and Samples, and the following supplemental requirements as applicable:

1. For all pipes 24–inch and larger, and all pipe using non-standard fittings, line layout and marking diagrams shall be provided. The line layout and marking diagrams shall include the specific number of each pipe and fitting and the location of each pipe and the direction of each fitting in the completed line. In addition, the line layout shall include: the pipe station and invert elevation at all changes in grade or horizontal alignment; the station and invert elevation to which the bell end of each pipe will be laid; all elements of curves and bends, both in horizontal and vertical alignment; the limits of each reach of restrained and/or welded joints; and the limits of concrete encasement.

2. Drawings showing the location, design, and details of bulkheads for hydrostatic testing of the pipeline, and details for removal of test bulkheads and repair of any pipe lining.

3. A hydrostatic test plan demonstrating compliance with Section 02640 – Pipeline Testing and Disinfection.

4. Details and locations of closures for length adjustment and for construction convenience.

5. Detail drawings indicating the type, number and other pertinent details of the slings, strutting and other methods proposed for pipe handling during manufacturing, transport and installation.

B. Manufacturer's handling and installation instructions.

PART 2 PRODUCTS

2.1 GENERAL

A. Pipe Material Options

1. The pipe schedule, located in the Mechanical Details, shall define the allowable options for pipe material, based on fluid type.

2. Pipe material designations and transitions on the drawings shall take precedence over the options presented in the pipe schedule.

3. Depending on the pipe material selected by the Contractor, the applicable details for corrosion protection and thrust restraint shall apply.

4. Transition from mortar lined and mortar coated steel pipe shall be composed of a flanged end on the steel pipe and a flange-coupling adaptor or flexible coupling on the non-steel pipe, as appropriate.

B. Corrosion Control: All required corrosion control measures shall be provided, installed and tested in accordance with the Pipe Schedule, Section 09900 – Painting and Coatings, and all other applicable drawings, details and specifications.

C. Marking: The Contractor shall legibly mark all shop-fabricated specials 24 inches in diameter and larger and all mitered pipe in accordance with the laying schedule and marking diagram. Each marked element shall be numbered in sequence and said number shall appear on the laying schedule and marking diagram in its proper location for installation. A mark indicating the true vertical axis of each marked pipe, special and fitting shall be placed on the top and bottom of the pipe, special or fitting.

D. Pipe identification

1. Detection Wire: Detection wire shall be a solid No. 12 or 10 A.W.G. copper wire with 0.45 mils Type HMW – PE purple insulation laid along the top of all plastic pipe and held in place with ties or hitches of the same kind of wire spaced not more than 13 feet apart. The wire shall meet the requirements of ASTM D1351 and ASTM B8. Detection wire shall be UL listed as direct burial wire at temperatures between -40 degrees and 75 degrees C for circuits not exceeding 600 volts.

2. Detection wire shall be terminated at structure connections or pipe locator boxes as indicated on the Drawings. Pipe locator boxes shall be located a maximum of 500-feet apart.

3. Pipe Locator Tape: Pipe locator tape shall be installed above all buried pipes as shown on the Drawings. Pipe locator tape shall be minimum 6 mil thickness, colored tape suitable made out of polyolefin film with imprinted wording. The wording shall be approved by the Engineer for each pipe service prior to installation. The material and ink used shall be permanent and shall not degrade in typical underground soil environments. The tape shall be a minimum 3 inches wide, and shall be Terra Tape Premium as manufactured by Reef Industries, or approved equal.

E. Pipe Testing: Pipe material testing shall be in accordance with the pipe material specifications and the applicable Commercial Standards. Pipe functional and performance testing shall be in conformance with Section 02640 – Pipeline Testing and Disinfection.

F. Pipe material changes shall be as indicated in the Contract Drawings and in the Process Fluid Schedule.

G. Bolts and Hardware

1. Standard Service (non-corrosive application): Unless otherwise noted, bolts, anchor bolts, washers and nuts shall be steel, galvanized after fabrication as indicated herein. Threads on galvanized bolts and nuts shall be formed with suitable taps and dies such that they retain their normal clearance after hot-dip galvanizing. Except as otherwise indicated, steel for bolts, anchor bolts and cap screws shall be in accordance with the requirements of ASTM A194 Grade B-7.

2. Corrosive Service: All bolts and nuts in the locations listed below shall be stainless steel. Washers shall be phenolic insulating type.

   a. All buried locations.
   b. All submerged locations.
   c. All locations subject to seasonal or occasional flooding.
   d. Inside hydraulic structures below the top of the structure.
   e. Inside buried vaults, manholes and structures which do not drain through a gravity sewer or to a sump with a pump.
   f. All chemical handling areas.
   g. Inside trenches, containment walls and curbed areas.
   h. Locations indicated by the Contract Documents or designated by the Engineer to be provided with stainless steel bolts.

3. Unless otherwise noted, stainless steel bolts, anchor bolts, nuts and washers shall be Type 316 stainless steel, Class 2, conforming to ASTM A193 for bolts and to ASTM A194 for nuts. All threads on stainless steel bolts shall be protected with an antiseize lubricant suitable for submerged stainless steel bolts, to meet government specification MIL-A-907E. Buried bolts in poorly draining soil shall be coated the same as the buried pipe.

   a. Antiseize lubricant shall be classified as acceptable for potable water use by the NSF.

b. Antiseize lubricant shall be “Pure White” by Anti-Seize Technology, Franklin Park, IL, 60131, AS-470 by Dixon Ticonderoga Company Lakehurst, NJ, 08733, or equal.

4. Bolt Requirements

a. Bolt and nut material shall be free-cutting steel.
b. The nuts shall be capable of developing the full strength of the bolts. Threads shall be Coarse Thread Series conforming to the requirements of the American Standard for Screw Threads. All bolts and cap screws shall have hexagon heads and nuts shall be Heavy Hexagon Series.
c. All bolts and nuts shall be installed with washers fabricated of material matching the base material of the bolts, except that hardened washers for high strength bolts shall conform to the requirements of the AISC Specification. Lock washers shall be installed with washers where indicated and shall be fabricated of material matching the bolts.
d. The length of all bolts shall be such that after joints are made up, each bolt shall extend through the entire nut, but in no case more than 1/2-inch beyond the nut.

H. Pipe Encasement: Concrete encasement of pipes shall utilize the reinforcing steel in the sizes and arrangements as shown in the General Civil Details and as specified in Section 03200 – Concrete Reinforcement. Concrete for encasement shall be as specified in Section 03300 – Cast-In-Place Concrete.

I. Process Fluid Schedule: The process fluid schedule is found in the Pipe Schedule. Material types shall be as designated in the Process Fluid Schedule unless otherwise noted in the Contract Drawings. Physical locations of pipe material changes are indicated on the Contract Drawings by the symbol defined in the General Drawings.

J. Insulation Flanges: Insulation flanges shall be provided on all metallic pipes at the buried pipe-exposed pipe transitions and at buried pipe-buried concrete encased pipe under structures. Insulation flanges shall be as shown on the Contract Documents.

K. Trench Dams, Plugs: Trench dams and plugs shall be installed where indicated on the Contract Drawings or where specified in Section 02200 – Earthwork and shall conform with the material requirements of Section 02200 – Earthwork and the General Civil Details.

L. Protective Coating: As required in individual pipe specs and as called for in Section 09900 – Painting and Coatings.

M. Utility Supports: All existing utilities that are encountered during the work shall be supported as shown in the General Civil Details or as otherwise specified in the Contract Documents.

PART 3 EXECUTION

3.1 DELIVERY AND STORAGE

A. All pipe, specials and fittings shall be handled, at a minimum, at the 1/3 points by use of wide fabric slings, padded cradles, or other devices acceptable to the Engineer, which are designed and constructed to prevent damage to the pipe coating. The use any equipment which might injure any pipe coating will not be permitted. Stockpiled pipe

shall be supported on sand or earth berms free of rock exceeding 3 inches in diameter. The pipe shall not be rolled and shall be secured to prevent accidental rolling. All other pipe handling equipment and methods shall be acceptable to the Engineer.

B. Handling and Storage: All pipe and fittings shall be carefully handled and protected against damage to lining and coating/interior and exterior surfaces, impact shocks, and free fall. Pipe shall not be placed directly on rough ground but shall be supported in a manner which will protect the pipe against injury whenever stored at the trench site or elsewhere. No pipe shall be installed when the lining or coating/interior or exterior surfaces show cracks that may be harmful as determined by the Engineer. Such damaged lining and coating/interior and exterior surfaces, shall be repaired or a new undamaged pipe shall be provided.

C. Fittings shall be lowered into trench carefully and without damage to the fittings. Any device used for lowering fitting into trench shall be attached around the exterior of the fitting for handling. Under no circumstances, shall any device be attached through the fitting's interior for handling.

D. All damaged pipe shall be repaired or replaced by the Contractor.

E. The Contractor shall inspect each pipe and fitting to insure that there are no damaged portions of the pipe. The Contractor shall remove or smooth out any fins, burrs, gouges, weld splatter, or other small defects prior to laying the pipe.

F. Store all pipe materials in accordance with pipe manufacturer's recommendations and the following requirements until installation.

1. Keep pipe at ambient outdoor temperature.

2. Provide temporary shading for plastic pipe.

3. Any covering practices that will cause a temperature build-up are not acceptable.

3.2 INSTALLATION OF PIPE AND APPURTENANCES

A. General

1. Piping and its installation shall be in accordance with Section 02200 – Earthwork, Section 02140 – Dewatering, Section 15000 – Piping, General and the following general requirements.

2. The Contractor shall provide all fittings, closure pieces, bends, reducers, wyes, tees, crosses, outlets, manifolds, and other specials, bolts, nuts, gaskets, jointing materials, and all other appurtenances as required to provide a complete and workable installation.

3. The Contractor shall provide support and protection for all crossing utilities exposed during construction.

4. The Contractor shall verify the type, size and condition of existing pipe prior to installing the new pipe. The pipe shall be inspected for corrosion of other conditions that would prevent an adequate connection. If dewatering of an existing line is required, a minimum of 14 days notice shall be given to the Owner

to allow for adequate time to prepare the line for the connection. Connections to dewatered lines shall be expedited to minimize service interruptions.

5. Locations of existing pipes are approximate. Contractor shall field verify connection locations prior to starting work or detailing shop drawings.

6. Where pipe is to be connected to concrete structures, the connection shall be made as shown on the Contract Documents or as modified herein. All pipes entering or leaving structures, except air, gas and solvent welded plastic pipe, shall be provided with a minimum of two flexible pipe segments. Differential settlement of up to two inches is anticipated for newly constructed structures, pipe transitions into and out of each new structure shall be laid out to accommodate this level of differential settlement as well.

7. Before excavation is started for any run of underground piping, the Contractor shall locate and expose all existing structures, piping, conduit, etc., which intersect the line of the piping, to avoid possible damage to these during excavation operations and so that it may be determined if there will be any conflicts in location. In the event of conflicts in location or grade or both, between new piping and existing piping, the Contractor shall make adjustments in location or grade of new piping as directed by the Engineer.

B. Layout and Grade

1. Pipe Laying: Unless otherwise required, all pipe shall be laid straight between the changes in alignment and at uniform grade between changes in grade. Pipe utilizing bell-and-spigot joints shall be laid with the bell end pointing in the direction of laying. Pipe shall not be laid when the conditions of trench or weather are unsuitable.

2. The Contractor shall not use the pipeline as a conductor for trench drainage.

3. Installation Tolerances: Where provisions of these Specifications require pipe laying diagrams, the pipe shall be laid in the order and position shown on the laying diagram and in accordance with the following:

   a. Each section of pipe having a nominal diameter less than 48 inches shall be laid to line and grade, within plus or minus 2 inches horizontal deviation and plus or minus 1-inch vertical deviation.
   b.
   c. Each section of pipe having nominal diameter 48 inches and larger shall be laid to line and grade, within plus or minus 5 percent of diameter horizontal deviation and plus or minus 2.5 percent of diameter vertical deviation.

   d. In addition to the horizontal and vertical tolerances above, lay the pipe so that no high or low points other than those on the laying diagram are introduced.
   e.
   f. On grades of zero slope, the intent is to lay the pipe as close as possible to level

4. Trench excavation, bedding, and backfill shall be in accordance with Section 02200 – Earthwork. Trenches shall be graded to provide a uniform and continuous support beneath the pipe at all points to prevent point loading at any location along the pipe section. Grade the bottom of the trench by hand to the line and grade to

which the pipe is to be laid, with proper allowance for pipe thickness and for gravel bedding when specified or indicated.

5. Trenches shall be in a reasonably dry condition when the pipe is laid. The trench shall be kept dry until the pipe laying and jointing are completed. Contractor shall dewater trenches to a depth of one foot below the invert of pipe to be installed. No pipe shall be laid in water or when, in the opinion of the Engineer, trench conditions are unsuitable. The Contractor may over-excavate and fill with coarse drain rock and geotextile filter fabric as specified in Section 02200 – Earthwork.

6. Necessary facilities including slings shall be provided for lowering and properly placing the pipe sections in the trench without damage. The pipe and specials shall be laid to the line and grade indicated and shall be closely jointed to form a smooth flow line. Immediately before placing each section of pipe in final position for jointing, the bedding shall be checked for firmness and uniformity of surface.

7. Immediately before placing each section of pipe in final position for jointing, the pipe bedding shall be checked for firmness and uniformity of surface.

8. At the location of each joint, dig bell (joint) holes of ample dimensions in the bottom of the trench and at the sides where necessary to permit easy visual inspection of the entire joint.

9. Pipe shall be laid directly on the imported bedding material. No blocking will be permitted, and the bedding shall be such that it forms a continuous, solid bearing for the full length of the pipe. Excavations shall be made as needed to facilitate removal of handling devices after the pipe is laid. Bell holes shall be formed at the ends of the pipe to prevent point loading at the bells or couplings. Excavation shall be made as needed outside the normal trench section at field joints to permit adequate access to the joints for field connection operations and for application of coating on field joints.

10. Driving pipe down to required grade by striking with shovel handle, timber, or other object is prohibited.

11. Large yard pipe, 12-inches in diameter or greater, shall be installed at the coordinates identified in the Contract Documents.

12. Small yard pipe, less than 12-inches in diameter, are shown in approximate locations in the Contract Documents and shall be installed by scaling their location from the Drawings.

13. Pipe shall be installed in accordance with the applicable reference standards and the supplemental requirements specified herein.

14. Where necessary to raise or lower the pipe due to unforeseen obstructions or other causes, the Engineer may change the alignment and/or the grades. Such change shall be made by the deflection of joints, by the use of bevel adapters, or by the use of additional fittings. However, in no case shall the deflection in the joint exceed 75% of the maximum deflection recommended by the pipe manufacturer. No joint shall be misfit any amount which will be detrimental to the strength and water tightness of the finished joint.

15. Where the grade or alignment of the pipe is obstructed by existing utility structures such as conduits, ducts, pipes, branch connections to main sewers or main drains, the construction shall be permanently supported, relocated, removed or reconstructed by the Contractor in cooperation with owners of such utility structures. Unless otherwise indicated and where utilities are shown in the Contract Drawings, this work shall be performed at the Contractor's expense.

16. Except for short runs which may be permitted by the Engineer, pipes shall be laid uphill on grades that exceed 10 percent. Pipe that is laid on a downhill grade shall be blocked and held in place until sufficient support is furnished by the following pipe to prevent movement. All bends shall be properly installed.

17. The Contractor shall take all necessary precautions to prevent the pipe from floating due to water entering the trench from any source, shall assume full responsibility for any damage due to this cause, and shall at its own expense restore and replace the pipe to its specified condition and grade if it is displaced due to floatation.

18. All drainage or gravity flow pipe shall maintain an average slope between elevations as indicated on the drawings, as described in this Section, to clear an interference. In no case shall the pipe slope be less than 0.20 percent unless noted otherwise.

19. All pressure (non-gravity) pipe shall be installed with a slope to allow free drainage to blow-off valves or structures. Elevations indicated on the drawings are maximum and can be lowered to accommodate interferences provided free drainage can be maintained.

20. Slope of pressure pipe between structures, when no intermediate blow-offs are shown, can be adjusted, provided adequate adjustment exists inside structures to provide free drainage.

21. All pipe shall have a minimum cover greater than 2'-6" unless noted otherwise.

22. Where minimum cover can not be maintained, the pipe shall be concrete encased per General Civil Details. In no case shall the concrete encasement be exposed above the ground or take the place of minimum asphalt paving thickness.

23. Pipe, shown concrete encased under structures, shall be concrete encased to a minimum distance beyond the structure equal to the footing clearance.

24. No pipe shall be installed so that it is under tension. Make allowance for thermal expansion/contraction when installing pipe, particularly plastic pipe, in warm temperatures; otherwise the pipe will be in tension when it cools. Flexible plastic pipe can be "snaked" in the trench to prevent cooling into tension.

C. Support

1. Thrust restraint shall be provided where indicated and joints shall be provided as indicated or otherwise noted in the Contract Documents.

2. Anchors and supports shall be provided where necessary and where indicated on the drawings for fastening work into place. Fittings shall be independently supported.

D. Handling

1. Cold Weather Protection: No pipe shall be installed upon a foundation into which frost has penetrated or at any time that there is a danger of the formation of ice or penetration of frost at the bottom of the excavation. No pipe shall be laid unless it can be established that the trench will be backfilled before the formation of ice and frost occurs.

2. Proper implements, tools and facilities as recommended by the pipe manufacturer's standard printed installation instructions shall be provided and used by the Contactor for safe and efficient execution of the work.

E. Cleaning

1. Pipe and Specials Protection: The openings of all pipe and specials where the pipe and specials have been mortar lined in the shop shall be protected with suitable bulkheads to maintain a moist atmosphere and to prevent unauthorized access by persons, animals, water, or any undesirable substance. The bulkheads shall be so designed to prevent drying out of the interior of the pipe.

2. Before placement of pipe in a trench, each pipe or fitting shall be thoroughly cleaned of any foreign substance, which may have collected thereon and shall be kept clean at all times thereafter. For this purpose, at all times when the work of installing pipe is not in progress, all openings into the pipe and the ends of the pipe in trenches or structures shall be kept tightly closed to prevent entrance of animals, water and foreign material. The use of burlap, wood or other similar temporary plugs will not be permitted.

3. If water is in the trench, do not remove trench closure devices until provisions are made to prevent water, earth or other substances/material from entering the pipe.

4. Pipe Cleanup: As pipe laying progresses, the Contractor shall keep the pipe interior free of all debris. The Contractor shall completely clean the interior of the pipe of all sand, dirt, mortar splatter, and any other debris following completion of pipe laying, pointing of joints as applicable, and any necessary interior repairs prior to testing and disinfecting the completed pipeline. The Contractor shall maintain the inside of the pipe free from foreign materials and in a clean and sanitary condition until acceptance by the Owner.

5. Never weld close to plastic pipe without protecting the pipe with a heat-resistant baffle or a wet rag. Perform welding on pipe connected and immediately adjacent to plastic pipe to minimize the possibility of directing sparks or hot material into the plastic from inside the pipe.

F. Installation of Pipeline Appurtenances:

1. Unless noted otherwise, buried appurtenance shall be coated with the same material and thickness as the adjoining pipe.

2. All valves shall be handled in a manner to prevent any injury or damage to any part of the valve. The Contractor shall adjust all stem packing and operated each valve prior to installation to insure proper operation. All valves shall be installed so that the valve stems are plumb and in the location shown.

3. All buried valves, flanges, couplings and other appurtenances shall be coated and protected in accordance with Section 09900 – Painting and Coatings.

4. Installation of Flanged Joints: Before the joint is assembled, the flange faces shall be thoroughly cleaned of all foreign material with a power wire brush. The gasket shall be centered and the connecting flanges drawn up watertight without unnecessarily stressing the flanges. All bolts shall be tightened in a progressive diametrically opposite sequence and torqued with a suitable, approved, and calibrated torque wrench. All clamping torque shall be applied to the nuts only. Full face reinforced rubber gaskets shall be applied to the inside face of blind flanges with adhesive.

5. Flexible Coupled Joints: When installing flexible couplings, care shall be taken that the connecting pipe ends, couplings and gaskets are clean and free of all dirt and foreign matter with special attention being given to the contact surfaces of the pipe, gaskets, and couplings. The couplings shall be assembled and installed in conformity with the recommendation and instruction of the coupling manufacturer.

6. Wrenches used in bolting couplings shall be of a type and size recommended by the coupling manufacturer. Coupling bolts shall be tightened so as to secure a uniform annular space between the follower rings and the body of the pipe with all bolts tightened approximately the same amount. Diametrically opposite bolts shall be tightened progressively and evenly. Final tightening shall be done with a suitable, approved, and calibrated torque wrench set for the torque recommended by the coupling manufacturer. All clamping torque shall be applied to the nut only.

7. All fittings and appurtenances shall be installed utilizing standard installation procedures. Fittings and appurtenances shall be carefully connected to pipe or other facility, and joint shall be checked to ensure a sound and proper joint.

G. Thrust Restraint

1. Thrust restraint for yard piping shall be as indicated on the Contract Drawings and in the Civil Details. Thrust restraint requirements for each pipe material type are as indicated in the pipe material schedule. For restrained joint options, a minimum of one joint upstream and one joint downstream of a bend of 22.5 degrees or greater shall be restrained on otherwise unrestrained joint pipe.

2. Where allowed by the pipe material schedule and where used, mechanical restraints shall be Megalug brand, manufactured by EBAA Iron, Inc., or approved equal The mechanical restraints shall be installed according to the Civil Details.

3. For any joint whose size and test pressure combination is not specifically identified in the Civil Details, the Contractor shall submit thrust restraint calculations to the Engineer for approval prior to the fabrication and installation of the restrained joint.

4. Welded (heat or solvent) pipe, fused pipe or pipe with threaded joints shall not require the installation of additional thrust restraint.

5. Pipes with any form of push-on or compression joint shall require additional thrust restraint according to the Civil Details.

3.3 CORROSION CONTROL

A. Electrical Insulation: All buried metallic pipelines shall be electrically isolated from above-grade structures and at all terminations and all buried pipe-exposed pipe transitions and at buried pipe-buried concrete encased pipe under structures utilizing insulating flanges as shown in the Drawings. In addition, all pipes shall be electrically isolated from reinforcing bars as building/structure penetrations.

B. See Contract Plans and individual pipe specs for additional detail about corrosion control and coatings/encasements.

3.4 TESTING AND DISINFECTION

A. All completed pipelines shall be tested and disinfected in accordance with Section 02640 – Water Pipeline Testing and Disinfection.

END OF SECTION

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SECTION 02553– IN PLANT TEMPORARY BYPASS PUMPING

PART 1 GENERAL

1.1 THE REQUIREMENT

A. The Contractor shall provide temporary bypass pumping of wastewater flows on treatment plant sites as needed to complete the requirements of the Contract Documents. The following requirements shall apply to bypass pumping:

1. Provide all necessary labor, tools, materials, and supervision to provide standalone temporary bypass pumping system in accordance with the requirements of this Section.

2. Operate and maintain bypass pumping facilities including, but not limited to, pumps, piping, valves, temporary power, controls, and monitoring until the involved portion(s) of the Work have been completed to the satisfaction of the ENGINEER.

3. Bypassing wastewater in a way that assures that no wastewater is allowed to leak outside of the bypass system or plant facilities. If leakage does occur, pay all fines and reimburse the CITY for all costs associated with the cleanup of the leakage, as wells as costs associated with legal actions.

4. Accept responsibility for any release of wastewater and for penalties associated with bypass pumping activities, including commissioning, operating, and decommissioning of bypass pumping facilities.

5. Coordinate the placement of the bypass piping and pumping equipment with the CITY.

6. The means and methods of accomplishing and maintaining the temporary bypass pumping and associated facilities shall be the sole responsibility of the CONTRACTOR.

7. Except as otherwise specified or authorized in writing, no interruption of wastewater flow shall be permitted throughout the duration of the project. CONTRACTOR is responsible for all wastewater overflows during construction of this work and bypass operations.

8. Take precautions to prevent any potential spillage of wastewater from entering the stormwater system.

9. Temporary bypass pumping operation:

   a. Limited to the months, times, or seasons indicated in this Section and Section 01010, unless approved in writing by the ENGINEER.
   b. Continuous operation for 24 hours per day and 7 days per week is anticipated during the period of Work unless otherwise noted.

10. Continuously monitor temporary bypass pumping.

11. Provide qualified operators continuously during operation of the bypass systems.

B. Related sections:

1. The Contract Documents are complementary; what is called for by one is as binding as if called for by all.

2. It is the CONTRACTOR's responsibility for scheduling and coordinating the Work of subcontractors, suppliers, and other individuals or entities performing or furnishing any of CONTRACTOR's Work.

3. The following Sections are related to the Work described in this Section. This list of Related Sections is provided for convenience only and is not intended to excuse or otherwise diminish the duty of the CONTRACTOR to see that the completed Work complies accurately with the Contract Documents.

   a. Section 01010 - Summary of Work.
   b. Section 02565 - Ductile Iron Pipe (AWWA C151, Modified).
   c. Section 15200 – Valves, General.
   d. Section 15230 – Miscellaneous Valves.

1.2 REFERENCE SPECIFICATIONS, CODES, AND STANDARDS

A. National Fire Protection Association (NFPA):

1. 820 – Standard for Fire Protection in Wastewater Treatment and Collection Facilities.

1.3 CONTRACTOR SUBMITTALS

A. Prepare and submit a project-specific wastewater bypass pumping plan with completed wastewater bypass pumping checklist.

1. Be advised that the bypass plan must provide accessibility for pedestrians and vehicular traffic in accordance with Article 7.4 of the General Conditions.

B. Wastewater bypass pumping plan shall include the following at a minimum:

1. Number, capacities, and sizes of pumps and piping, standby equipment, and power requirements, if applicable.

2. Design calculations of the system and selected equipment, including flow, TDH with static head including all friction and minor losses, pump curves showing operating range of flow and TDH at minimum, average, and peak flow.

3. Standby power generator size and location for electrically-driven bypass pumps.

4. Downstream discharge plan.

5. Pipe thrust and restraint types, sizes, and locations.

6. Temporary pipe supports and anchoring required.

7. Plans for access to bypass pumping locations.

8. Schedule that shows duration of temporary bypass pumping including milestones for installation, maintenance, and removal of equipment and accessories.

9. Means and methods of installing, operating, monitoring, and maintaining the temporary bypass pumping.

10. Plan indicating bypass pumping line locations.

    a. Include details showing methods used to protect and identify the bypass pumping lines through the length of the bypass route.

11. Detailed plans of a backup system.

12. Address access for pedestrians and vehicular traffic.

13. Mechanical plan showing equipment, valves, pipe sizes and locations, pipe materials, dimensions, vehicle access (where applicable), pedestrian access (where applicable).

14. Schematic drawings and written description of the control system and its' operating sequence.

15. Proposed type and location of temporary plugs, bulkheads, and weirs.

16. Catalog cut sheets for pumping equipment, pipe and fittings, valves.

17. Emergency response plan.

18. Staffing plan.

19. Spill prevention and cleanup plan.

20. Noise control system.

21. Health and safety plan.

22. Operating permits from jurisdictional air quality agency for each engine (if applicable).

1.4 QUALITY ASSURANCE

A. CONTRACTOR's qualifications:

1. Minimum 5 years experience in performing substantially similar temporary bypass operations.

2. Submit evidence of satisfactory operation of temporary bypass facilities similar to those specified in at least 5 separate projects in accordance with the specifications, including references.

B. Fulfillment of the specified experience requirements shall be a condition of acceptance.

PART 2 PRODUCTS

2.1 CAPACITY

A. Pumps, piping and accessories shall be of adequate capacity and size to handle the range of wastewater flows from minimum flow to peak flow.

B. Piping, fittings, and all accessories shall withstand 1.5 times the maximum pressure.

C. Maintain on site sufficient equipment and materials to ensure continuous and successful operation of the bypass system.

1. Have standby pump(s) on site to provide 100 percent redundancy of the bypass system design Peak Flow.

   a. The redundant pump(s) shall be plumbed, fueled, and ready for operation at all times.

2. Maintain on site a sufficient number of valves, tees, elbows, connections, tools, pipe plugs, piping, and other parts or system hardware to ensure immediate repair or modification of any part of the bypass system as necessary.

2.2 BYPASS PUMPS

A. Provide a minimum of 2 pumps: 1 duty and 1 standby.

B. Pump capacity: Sufficient to pump the anticipated peak hour flow with the largest pump out of service.

C. Pumps: Packaged units with a skid base or trailer.

D. Pumps: Fully automatic, self-priming, close-coupled centrifugal units that do not require use of foot valves or vacuum pumps for priming.

E. Pumps shall use oil-lubricated mechanical seal.

F. Pump materials: As follows:

1. Volute: Cast iron.

2. Impeller: Cast iron.

3. Pump shaft: Type 431 stainless steel.

4. Mechanical seal faces: Silicon carbide.

G. Pumps shall be capable of passing 3-inch diameter solids, rags, rocks, hair and other debris encountered in municipal wastewater.

H. Pump driver: Diesel engine and include the following:

1. Minimum 24-hour capacity diesel fuel tank as defined by fuel consumption during peak pumping rate.

2. Fuel gauge with red warning light when tank approaches empty.

I. Maximum pump speed: Not exceeding 2,200 revolutions per minute.

J. The system shall include the following features:

1. START/STOP operation.

2. Instrumentation and controls for operation and monitoring for each pump.

K. Electrical equipment, instrumentation and accessories: Suitable for Class 1 Division 1 service as defined by NFPA 820.

L. Comply with applicable air quality regulations.

2.3 BYPASS PIPING

A. Use ductile iron piping with grooved joints for the temporary bypass pumping system. Piping and fittings shall meet the requirements of Section 02565.

B. Pipe integrity: 0 leakage.

a. Include spill containment vessels or “spillguards” as required.

C. Provide sewage type air release valve at high point in piping and containment spills from valves.

1. Sewage type air release valve shall be per Section 15230.

D. Provide temporary ramps constructed over pipelines 6 inches in diameter or less to allow access to driveways.

1. Bury pipelines larger than 6 inches in diameter crossing driveways, a minimum of 6 inches below the existing ground or pavement surface and backfilled with temporary asphalt concrete.

2. No driveway access shall be blocked without the written authorization of the CITY.

2.4 ISOLATION OF EXISTING PIPES AND CHANNELS

A. Pipe diameters 24 inches and smaller: Mechanical plugs with EPDM gaskets.

B. Pipe diameters larger than 24 inches: Inflatable bag stoppers with 2 or more pieces. Provide 2 plugs in series.

C. Provide temporary bulkheads to isolate channels as required to perform bypass pumping Work.

D. Provide temporary weirs as required to maintain constant head in channel on suction side of temporary pumping system.

2.5 NOISE CONTROL

A. Pumping equipment: Equipped with devices or enclosures for noise attenuation including but not limited to mufflers and/or acceptable noise panels or enclosures.

B. The noise level shall be at or below 75 dBA at 15 feet from the pumping equipment for the duration of the work.

PART 3 EXECUTION

3.1 GENERAL

A. Notify the CITY a minimum of 30 days prior to the WORK and the notify the ENGINEER at least 72 hours prior to bypassing or diverting flow in any of the pipelines or laterals.

B. Place pumps, generators, and other equipment on a plastic tarp to protect against spills of petroleum products used by the equipment.

C. Before taking plant, process, pipeline, or channel out of service, verify that bypass system is fully operational and acceptable to ENGINEER.

3.2 PROTECTION

A. Be responsible for all bypass flows.

1. Inspect the entire bypass pumping and piping system for leaks or spills at a frequency of not less than 1 time per shift.

2. Do not shutdown the temporary bypass system between shifts, on holidays or weekends, or during work stoppages without written permission from the ENGINEER.

B. Provide trained and qualified attendants 24 hours per day 7 days per week until the bypassing is no longer required. The attendants shall:

1. Be capable of performing pump and piping maintenance as required.

2. Have cellular phones for communication with the CONTRACTOR and the CITY in the event of emergencies.

C. No bypassing to the ground surface, receiving waters, storm drains, or bypassing which results in soil or groundwater contamination or any potential health hazards shall be permitted.

1. In the event of any wastewater spill, be responsible for the prompt cleanup and disinfecting of the spill as called for in the wastewater bypass pumping plan.

2. Compensate the CITY for the cost of any fines levied as the result of a spill or unauthorized discharge.

D. Implement measures to prevent interference between plant staff and the bypass pumping equipment, pipelines and wastewater.

E. Take precautions to protect all bypass lines from damage.

1. Clearly identify above ground portions of the bypass lines by flashers, fencing, or other means to warn of their presence.

3.3 FIELD QUALITY CONTROL

A. Hydrostatic pressure test:

1. Prior to operation, test each section of discharge piping with maximum pressure equal to 1.5 times the maximum operating pressure.

2. Conduit test for a duration of 2 hours.

3. Test using Potable Water. Plant utility water may be acceptable with ENGINEER or CITY approval.

4. The line in service after test if the pressure has been maintained and there are no observable leaks.

5. Notify ENGINEER at least 48 hours prior to testing.

B. Inspection:

1. Inspect temporary bypass piping system at a minimum of once per shift.

2. An attendant/operator shall be present to monitor the operation of the bypass pumps at all times 24 hours per day.

3. Inspection log: Keep at each pumping location.

3.4 CLEAN-UP

A. The temporary bypass pumping system: Flush, clean and drain prior to dismantling.

B. Dispose of flushing water in approved manner.

C. Disturbed areas: Upon completion of bypass pumping operation, clean disturbed areas, restoring to original condition, including pavement restoration, at least equal to that which existed prior to start of WORK.

3.5 SYSTEM CONDITIONS

A. System conditions provided in Table A. For bypass pumping not indicated in Table A, obtain system conditions for bypass pumping and piping from the ENGINEER or CITY.

Table A – System Conditions

Bypass		**Route**		**Flows**	
No.	**Description**	**From**	**To**	**Range (gpm)**	**Conditions**
1	Mixed liquor bypass pumping	Ox Ditch Nos. 1 and 2 at Effluent Weir	Clarifier Splitter Box	700-4860	Provide bypass pumping during 36” ML tie-in to existing pipe stub out as needed.

2	Secondary effluent bypass pumping	Secondary Clarifier No 1 and 2	Filter feed pump station	700-4860	Provide bypass pumping during 24” SE tie-in to existing pipe as needed. If secondary effluent is pulled from the clarifiers, the suction pipes shall be positioned to avoid conflict with the skimming equipment.
3	CCT Influent Channel	CCT Influent Channel	CCT Basin No. 1 Influent	700-4860	Provide bypass as needed to modify CCT Basins 2A and 2B.
4	CCT Effluent Channel	CCT Basin No. 1 Effluent	Parshall Flume Channel	700-4860	Provide bypass as needed to modify CCT Basins 2A and 2B.

END OF SECTION

SECTION 02565 – DUCTILE IRON PIPE (AWWA C151, MODIFIED)

PART 1 GENERAL

1.1 THE REQUIREMENT

A. CONTRACTOR shall furnish and install all ductile iron pipe and all appurtenant work, complete in place, including connections to existing and new structures, in accordance with the requirements of the CONTRACTOR Documents.

B. The requirements of Section 02500 – Buried Pipe Installation apply unless stated otherwise herein.

1.2 REFERENCE SPECIFICATIONS, CODES, AND STANDARDS

A. ANSI

B. AWWA

1.3 CONTRACTOR SUBMITTALS

A. Shop Drawings and Samples: Shop drawings and samples shall be submitted in accordance with the requirements of Section 01340 – Shop Drawings, Product Data and Samples, Section 02500 – Buried Pipe Installation, the requirements of the reference standards, and the following supplemental requirements.

1. Materials lists and steel reinforcement schedules, as applicable, which describe all materials to be utilized.

2. Design calculations for wall thickness for all pipe whose thickness is not specifically defined and for all restrained joint length requirements not specifically defined.

3. Manufacturer's written Quality Assurance/Control Program.

4. Certified dimensional drawings of all valves, fittings, and appurtenances.

B. Certifications: CONTRACTOR shall furnish a certified affidavit of compliance to the ENGINEER guaranteeing that the pipe and other products or materials furnished hereunder is in compliance with the requirements of these Specifications, the reference standards and the following supplemental requirements:

1. Physical and chemical properties for the material components of all pipe, specials and appurtenances.

2. Hydrostatic test reports for pipe and rubber gaskets, where applicable.

3. Results of production weld tests as applicable.

4. Sand, cement and mortar tests as applicable.

5. Rubber gasket tests, as applicable.

C. All expenses incurred in making samples for certification of tests shall be borne by the CONTRACTOR at no increased cost to the OWNER.

1.4 QUALITY ASSURANCE

A. CONTRACTOR shall submit the following:

B. Inspection: All pipe shall be subject to inspection at the place of manufacture in accordance with the requirements of the applicable referenced standards as supplemented by the requirements herein. The CONTRACTOR shall notify the ENGINEER in writing of the manufacturing starting date not less than 14 calendar days prior to the start of any phase of the pipe manufacture.

C. During the manufacture of the pipe, the ENGINEER shall be given access to all areas where manufacturing is in process and shall be permitted to make all inspections necessary to confirm compliance with the Specifications

D. Tests: Unless otherwise specified, all material used in the manufacture of the pipe shall be tested in accordance with the requirements of the applicable referenced standards.

E. The CONTRACTOR shall perform all material tests at no additional costs to the OWNER. The ENGINEER shall have the right to witness all testing conducted by the CONTRACTOR provided that the CONTRACTOR's schedule is no delayed for the convenience of the ENGINEER. In addition to those test specifically required, the ENGINEER may request additional samples of any material for testing by the OWNER. The additional samples shall be furnished at no additional cost to the OWNER.

PART 2 PRODUCTS

2.1 GENERAL

A. Mortar-lined and polyethylene encased ductile iron pipe shall conform to ANSI/AWWA C151, C104, and C105, subject to the modifications contained herein. The pipe shall be of the diameter and class shown, shall be furnished complete with rubber gaskets as indicated in the Contract Documents, and all specials and fittings shall be provided as required under the Contract Documents.

B. Laying Lengths: Maximum pipe laying lengths shall be 20 ft with shorter lengths provided as required by the Drawings.

C. Finish: The pipe shall have smooth dense interior surfaces and shall be free from fractures, excessive interior surface crazing and roughness.

D. Bonding and Electrical Conductivity: All pipe joints shall be prepared for bonding for electrical conductivity in accordance with the details shown. The CONTRACTOR shall furnish all materials required for joint bonding and electrolysis test station installations.

E. Closures and Correction Pieces: Closures and correction pieces shall be provided as required so that closures may be made due to different headings in the pipe laying operation and so that correction may be made to adjust the pipe laying to conform to pipe stationing shown on the Drawings.

F. Gaskets for the Dryer Off-Gas Condenser drain piping (flanged, mechanical joint, push-on, etc) shall have a maximum service temperature of 200 degrees F.

2.2 MATERIAL

A. Ductile Iron Pipe: Pipe materials shall conform to the requirements of ANSI/AWWA C151.

B. Cement: Cement for mortar lining shall conform to the requirements of ANSI/AWWA C104; provided, that cement for mortar lining shall be Type II or V. A fly ash or pozzolan shall not be used as a cement replacement.

2.3 SPECIALS AND FITTINGS

A. Fittings for ductile iron pipe shall conform to the requirements of ANSI/AWWA C153/A21.53 or ANSI/AWWA C110/A21.10 for diameters 3-inch through 48-inch and shall have a minimum pressure as shown on the Drawings for the higher class of adjoining pipe.

2.4 DESIGN OF PIPE

A. General: The pipe furnished shall be ductile iron pipe, mortar-lined and polyethylene-encased, with rubber-gasketed joints.

B. The pipe shall be designed, manufactured, tested, inspected, and marked according to applicable requirements previously stated and except as hereinafter modified, shall conform to ANSI/AWWA C151.

C. Pipe Dimensions: The pipe shall be of the diameter and class shown on the Contract Drawings.

D. Fitting Dimensions: The fittings shall be of the diameter and class shown.

E. Joint Design: Ductile iron pipe and fittings shall be furnished with mechanical joints, push-on joints, flanged joints, and restrained joints as required.

1. Mechanical and push-on joints shall conform to ANSI/AWWA C111/A21.11

2. Flanged joints shall conform to ANSI/AWWA C115/A21.15. Gaskets shall be 1/8-inch thick, full face, cloth inserted rubber, corrosive acid and alkali free conforming to ANSI B16.21 and ANSI/AWWA C207.

3. Restrained joints shall be “Megalug” by EBAA Iron Inc., or equal.

F. For bell-and-spigot ends with rubber gaskets, the clearance between the bells and spigots shall be such that when combined with the gasket groove configuration and the gasket itself, will provide watertight joints under all operating conditions when properly installed. The CONTRACTOR shall require the pipe manufacturer to submit details complete with significant dimensions and tolerances and also to submit performance data indicating that the proposed joint has performed satisfactorily under similar conditions. In the absence of a history of field performance, the results of a test program shall be submitted.

2.5 CEMENT-MORTAR LINING

A. Cement-Mortar Lining for Shop Application: Except as otherwise provided herein, interior surfaces of all ductile iron pipe, fittings, and specials shall be cleaned and lined in the shop with cement-mortar lining applied centrifugally in conformity with ANSI/AWWA C104. During the lining operation and thereafter, the pipe shall be maintained in a round

condition by suitable bracing or strutting. The lining machines shall be of a type that has been used successfully for similar work. Every precaution shall be taken to prevent damage to the lining. If lining is damaged or found faulty at delivery site, the damaged or unsatisfactory portions shall be replaced with lining conforming to these Specifications.

B. The minimum lining thickness shall be as follows:

Nominal Pipe Diameter (in)	Minimum Lining Thickness (in)
3 to 12	1/8
14 to 24	3/16
30 to 54	1/4

C. Protection of Pipe Lining/Interior: All shop-applied cement mortar lining shall be given a seal coat of asphaltic material in conformance with ANSI/AWWA C104.

2.6 EXTERIOR COATING OF PIPE

A. The exterior surfaces of pipe which will be exposed to the atmosphere inside structures or above ground shall be thoroughly cleaned and then given a shop coat of rust-inhibitive primer conforming to the requirements of Section 09900 – Paints and Coatings.

2.7 EXTERIOR COATING OF BURIED PIPING:

A. Buried ductile iron pipe, joints, valves and fittings shall be encased in a polyethylene film that meets the material specifications of ANSI/AWWA C105/A21.5. Tape used in the installation of the polyethylene film shall be polyethylene.

PART 3 EXECUTION

3.1 DELIVERY AND STORAGE

A. All pipe specified under this Section shall be handled according to the provisions of Section 02500 – Buried Pipe Installation.

3.2 INSTALLATION

A. Pipe Laying: The pipe shall be installed in accordance with ANSI/AWWA C600 and the provisions of Section 02500 – Buried Pipe Installation.

3.3 EXTERIOR COATING

A. Polyethylene encasement shall be installed on ductile iron pipe, joints, valves and fittings in accordance with the requirements of ANSI/AWWA C105/A21.5.

3.4 RUBBER-GASKETED JOINTS

A. Rubber Gasketed Joints: Immediately before jointing pipe, the bell end of the pipe shall be thoroughly cleaned, and a clean rubber gasket lubricated with an approved vegetable-based lubricant shall be placed in the bell groove. The spigot end of the pipe shall be carefully cleaned and lubricated with a vegetable-based lubricant. The spigot end of the pipe section shall then be inserted into the bell of the previously laid joint and telescoped

into its proper position. Tilting of the pipe to insert the spigot into the bell will not be permitted.

3.5 CORROSION CONTROL

A. Electrical Continuity: Except where otherwise specified, all non-welded joints shall be bonded in accordance with the details shown. The pipe shall be cleaned to bare bright metal at the point where the bond is installed and the bond wire installed utilizing procedures in accordance with the requirements of Section 13111 – Cathodic Protection, and as shown in the Drawings.

B. Electrical Insulation: All buried pipelines shall l be electrically isolated from reinforcing bars as building/structure penetrations.

C. Cathodic Protection: All buried piping and fittings shall be provided with cathodic protection consisting of magnesium anodes or backfilled with controlled low strength backfill in accordance with the requirements of Section 13111 – Cathodic Protection, and as shown in the Drawings.

3.6 FIELD COATING OF EXPOSED PIPE

A. Apply field coating to all exposed pipe in accordance with Section 09900 – Painting and Coatings.

END OF SECTION

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SECTION 02571 – STEEL PIPE, LINED AND COATED

PART 1 GENERAL

1.1 THE REQUIREMENT

A. The Contractor shall furnish and install all lined and coated steel pipe, fittings, steel plate specials and all appurtenant work, complete in place, including connection to existing and new structures, all in accordance with the Contract Documents.

B. All pipe specified under this Section shall conform to the requirements of Section 02500 – Buried Pipe Installation.

1.2 CONTRACTOR SUBMITTALS

A. Shop Drawings: The Contractor shall submit Shop Drawings of pipe, fittings, and appurtenances in accordance with the requirements in Section 01340 – Shop Drawings, Product Data and Samples, Section 02500 – Buried Pipe Installation, the requirements of the referenced standards and the following supplemental requirements.

1. Joint and pipe/fitting wall construction details which indicate the type and thickness of cylinder; the position, type, size, and area of reinforcement; coating and lining holdbacks, manufacturing tolerances; and all other pertinent information required for the manufacture of the product.

2. Fittings and specials details such as elbows, wyes, tees, outlets, connections, test bulkheads, and nozzles or other specials which indicate amount and position of all reinforcement.

3. Design calculations (including a complete stress analysis) of each girth joint and specials – all sufficient to ascertain conformance of pipe and fittings with the Specifications. These shall be submitted to the Engineer for review prior to manufacture of pipe specials.

4. Material lists and steel reinforcement schedules that describe all materials to be utilized.

5. Design calculations for wall thickness for all pipe whose thickness is not specifically defined and for all restrained joint length requirements not specifically defined.

6. Line layout and marking diagrams that indicate the specific number of each pipe and fitting and the location of each pipe and the direction of each fitting in the completed line. In addition, the line layouts shall include: the pipe station and invert elevation at all changes in grade or horizontal alignment; the station and invert elevation to which the bell end of each pipe will be laid; all elements of curves and bends, both in horizontal and vertical alignment; and the limits within each reach of restrained and/or welded joints or of concrete encasement.

7. Full and complete information regarding location, type, size, and extent of all welds shall be shown on the shop drawings. The shop drawings shall distinguish between shop and field welds. Shop drawings shall indicate by welding symbols or

sketches the details of the welded joints, and the preparation of parent metal required to make them. Joints or groups of joints in which welding sequence or technique are especially important shall be carefully controlled to minimize shrinkage stresses and distortion.

8. Rubber gasket joint design and details.

9. Drawings showing the location, design, and details of bulkheads for hydrostatic testing of the pipeline, and details for removal of test bulkheads and repair of the lining.

10. Details and locations of closures for length adjustment and for construction convenience.

11. Detail drawings indicating the type, number, and other pertinent details of the slings, strutting, and other methods proposed for pipe handling during manufacturing, transport, and installation.

12. Manufacturer's written Quality Assurance/Control Program.

13. Calculations for reinforcement on all fittings and specials to withstand the internal pressure, both circumferential and longitudinal, and the external loading conditions specified and shown.

14. Manufacturer's written Quality Assurance/Control Program.

15. Certified dimensional drawings of all valves, fittings, and appurtenances.

B. Certifications: The Contractor shall furnish a certified affidavit of compliance to the Engineer guaranteeing that the pipe and other products or materials furnished hereunder is in compliance with the requirements of these Specifications, the reference standards and the following supplemental requirements:

1. Physical and chemical properties for the material components of all pipe, specials and appurtenances.

2. Hydrostatic test reports for pipe and rubber gaskets, where applicable.

3. Results of production weld tests as applicable.

4. Sand, cement and mortar tests as applicable.

5. Rubber gasket tests, as applicable.

C. All expenses incurred in making samples for certification of tests shall be borne by the Contractor at no increased cost to the Owner.

1.3 QUALITY ASSURANCE

A. Inspection: All pipe shall be subject to inspection at the place of manufacture in accordance with the requirements of the applicable referenced standards as supplemented by the requirements herein. The Contractor shall notify the Engineer in writing of the manufacturing starting date not less than 14 calendar days prior to the start of any phase of the pipe manufacture.

B. During the manufacture of the pipe, the Engineer shall be given access to all areas where manufacturing is in process and shall be permitted to make all inspections necessary to confirm compliance with the Specifications

C. Tests: Except as specified herein, all material used in the manufacture of the pipe shall be tested in accordance with the requirements of the applicable referenced standards.

D. Tests: Except as modified herein, all materials used in the manufacture of the pipe shall be tested in accordance with the requirements of ANSI/AWWA C200 and C205, as applicable.

1. Joint gaskets shall be tested in accordance with ANSI/AWWA C200.

2. After the joint configuration is completed and prior to lining with-cement-mortar, each length of pipe of each diameter and pressure class shall be shop-tested and certified to a pressure of at least 80 percent of the yield strength of the steel.

3. In addition to the tests required in ANSI/AWWA C200, weld tests shall be conducted on each 5,000 feet of production welds and at any other times there is a change in the grade of steel, welding procedure, or welding equipment.

4. If any special has been fabricated from straight pipe not previously tested and is of the type listed below, the special shall be hydrostatically tested with a pressure equal to 1-1/2 times the design working pressure: All bends, wyes, crosses, tees with side outlet diameter greater than 30 percent of the main pipe diameter, and manifolds.

5. All specials not required to be hydrostatically tested shall be tested by liquid dye penetrant inspection method in accordance with ASTM E 165 - Methods for Liquid Penetrant Inspection, Method A or the magnetic particle method in ASME Section VIII, Division 1, Appendix VI.

6. Reinforcing plates shall be tested by the solution method using approximately 40 psi air pressure introduced between the plates through a threaded test hole. Test hole shall be properly plugged following successful testing.

7. Any weld defects, cracks, leaks, distortion, or signs of distress during testing shall require corrective measures. Weld defects shall be gouged out and rewelded. After corrections, the special shall be retested.

8. Where welded test heads or bulkheads are used, extra length shall be provided to each opening of the special. After removal of each test head, the special shall be trimmed back to the design points with all finished plate edges ground smooth, straight, and prepared for the field joint.

9. Testing shall be performed before joints have been coated or lined

E. Ultrasonic Examination:

1. Steel plate that will be in welded joints or welded stiffener elements shall be examined ultrasonically for laminar discontinuities where both of the following conditions exist:

a. Any plate in the welded joint has a thickness exceeding 1/2-inch.

b. Any plate in the welded joint is subject to transverse tensile stress through its thickness during the welding or service.

2. Ultrasonic examination may be waived where joints are designated to minimize potential laminar tearing.

3. The ultrasonic examination shall be in accordance with ASTM A 578 - Straight Beam Ultrasonic Examination of Plain and Clad Steel Plates for Special Applications with a Level I acceptance standard.

4. Plates that are not in conformance with the acceptance criteria in ASTM A 578 may be used in the Work if the areas that contain the discontinuities are a distance at least four times the greatest dimension of the discontinuity away from the weld joint.

F. The Contractor shall perform all material tests at no additional costs to the Owner. The Engineer shall have the right to witness all testing conducted by the Contractor provided that the Contractor's schedule is no delayed for the convenience of the Engineer. In addition to those test specifically required, the Engineer may request additional samples of any material for testing by the Owner. The additional samples shall be furnished at no additional cost to the Owner.

G. Welding Requirements: All welding procedures used to fabricate pipe shall be prequalified under the provisions of ANSI/AWS D1.1 or ASME Pressure Vessel Code, Section 9. Welding procedures shall be required for longitudinal and girth or spiral welds for pipe cylinders, spigot and bell ring attachments, reinforcing plates and ring flange welds, and plates for lug connections

H. Welder Qualifications: All welding shall be done by skilled welders, welding operators, and tackers who have had adequate experience in the methods and materials to be used. Welders shall be qualified under the provisions of ANSI/AWS D1.1 or ASME Pressure Vessel Code, Section 9 by an independent local, approved testing agency not more than 6 months prior to commencing work on the pipeline. Machines and electrodes similar to those used in the Work shall be used in qualification tests. The Contractor shall furnish all material and bear the expense of qualifying welders at no increased cost to the Owner.

PART 2 PRODUCTS

2.1 GENERAL

A. Mortar-lined and mortar-coated steel pipe shall conform to ANSI/AWWA C200 and C205, subject to the following supplemental requirements. The pipe shall be of the diameter and class indicated, allowing for tolerances according to ANSI/AWWA C200 and C205, shall be provided complete with rubber gaskets or welded joints, as indicated in the Contract Documents, and all specials and bends shall be provided as required in this section.

B. Fusion bonded epoxy lined and coated steel pipe shall conform to ANSI/AWWAC200 and C213. The pipe shall be of the diameter and class indicated, allowing for tolerances according to ANSI/AWWA C200, shall be provided complete with rubber gaskets or welded joints, as indicated in the Contract Documents, and all specials and bends shall be provided as required in this section.

C. Steel piping shall be of the diameter and wall thickness as indicated in the Contract Documents. For pipe 14 inches in diameter and larger, the nominal inside diameter after any lining is applied shall not be less than the diameter shown on the Drawings, allowing for tolerances according to applicable standards. Pipe smaller than 14 inches in diameter may be furnished in standard outside diameters.

D. Strutting: Adequate strutting shall be provided on all specials, fittings, and straight pipe so as to avoid damage to the pipe and fittings during handling, storage, hauling, and installation. Details of the strutting assembly shall be submitted for review by the Engineer prior to start of pipe manufacture.

E. Laying Lengths: Maximum pipe laying lengths shall be 48 ft with shorter lengths provided as required by the Drawings.

F. Closures and Correction Pieces: Closures and correction pieces shall be provided as required so that closures may be made due to different headings in the pipe laying operation and so that correction may be made to adjust the pipe laying to conform to pipe stationing indicated. The locations of correction pieces and closure assemblies are shown. Any change in location or number of said items will have to be approved by the Engineer.

G. All vertical deflections shall fall on the alignment and at locations adjacent to underground obstructions, points of minimum earth cover, and pipeline outlets and structures. The pipe angle points shall match the angle points shown.

2.2 MATERIALS

A. Mortar: Materials for mortar shall conform to the requirements of ANSI/AWWA C205 - Cement-Mortar Protective Lining and Coating for Steel Water Pipe - 4-inch and Larger - Shop Applied; provided, that cement for mortar coating shall be Type II, and mortar lining shall be Type II or V. A fly ash or pozzolan shall not be used as a cement replacement. Admixtures shall contain no calcium chloride

B. Fusion Bonded Epoxy: Fusion bonded epoxy lining and coating shall be in accordance with Section 09900 – Painting and Coatings unless noted otherwise.

C. Steel for Cylinder and Fittings: Pipe manufactured under ANSI/AWWA C200 shall satisfy the following requirements:

1. Minimum yield strength of steel for pipe is 33,000 psi.

2. Be manufactured by a continuous casting process and be fully killed.

3. Be fine grain practice.

4. Have maximum carbon content of 0.25 percent.

5. Have maximum sulfur content of 0.015 percent.

6. Have minimum elongation of 22 percent in a 2-inch gauge length.

7. Be in accordance with one of the following:

a. ASTM A 1011 – Standard Specification for Steel, Sheet and Strip, Hot-Rolled, Carbon, Structural, High- Strength Low-Alloy and High-Strength Low-Alloy with Improved Formability

b. ASTM A 36 - Structural Steel

c. ASTM A 283 - Low and Intermediate Tensile Strength Carbon Steel Plates, Shapes, and Bars

d. ASTM A 572 - High Strength Low-Alloy Columbium-Vanadium Steels of Structural Quality

D. Steel equal to or greater than 1/2-inch thick used in fabricating pipe shall be tested for notch toughness using the Charpy V-Notch test in accordance with ASTM A 370 - Test Methods and Definitions for Mechanical Testing of Steel Products. Frequency of testing shall be one impact test (set of 3 specimens) for each coil used in manufacturing the pipe. The frequency for sheets and plates shall be one impact test (set of 3 specimens) and shall be made for each 30 tons of product. The steel shall withstand a minimum impact of 25 ft-lb at a temperature of 30 degrees F.

2.3 SPECIALS AND FITTINGS

A. Specials are defined as fittings, closure pieces, bends, reducers, wyes, tees, crosses, outlets, manifolds, and other steel plate specials wherever located, and all piping above ground or in structures.

B. Reinforcement for wyes, tees, outlets, and nozzles shall be designed in accordance with AWWA Manual M-11. Reinforcement shall be designed for the design pressure indicated and shall be in accordance with the Drawings. Specials and fittings shall be equal in pressure design strength and shall have the same lining and coating as the adjoining pipe. Unless otherwise indicated, the minimum radius of elbows shall be 2.5 times the pipe diameter and the maximum miter angle on each section of the elbow shall not exceed 11-1/4 degrees.

C. Moderate deflections and long radius curves may be made by means of beveled joint rings, by pulling standard joints, by using short lengths or pipe, or a combination of these methods; provided that pulled joints shall not be used in combination with bevels. The maximum total allowable angle for beveled joints shall be 5 degrees per pipe joint. Bevels shall be provided on the bell ends. Bevel-end joints shall not be pulled. Mitering of the spigot ends will not be permitted. The maximum allowable angle for pulled joints shall be in accordance with the manufacturer's recommendations or the angle which results from a 3/4-inch pull out from normal joint closure, whichever is less. All horizontal deflections or fabricated angles shall fall on the alignment.

D. Specials and fittings that cannot be mechanically lined and coated shall be lined and coated by hand-application using the same materials as used for the pipe and in accordance with the applicable AWWA or ASTM Standards, as modified by the applicable pipe section in these Specifications. Coating and lining applied in this manner shall provide protection equal to that for the pipe. Fittings may be fabricated from pipe that has been mechanically lined and/or coated. Areas of lining and coating that have been damaged by such fabrication shall be repaired by hand-applications.

E. Outlets, Tees, Wyes, and Crosses

1. Outlets 12-inch and smaller may be fabricated from Schedule 30 or heavier steel pipe in the standard outside diameters, i.e., 12-3/4-inch, 10-3/4-inch, 8-5/8-inch, 6-5/8-inch, and 4-1/2-inch. Minimum plate thickness for reinforcements shall be 10-gauge.

2. The design of outlet reinforcement shall be in accordance with the procedures given in Chapter 13 of AWWA Manual M-11, and the design pressures and factors of safety above.

3. In lieu of saddle or wrapper reinforcement as provided by the design procedure in Manual M-11, pipe or specials with outlets may be fabricated in their entirety of steel plate having a thickness equal to the sum of the pipe wall plus the required reinforcement.

4. Where Manual M-11 requires the design procedure for crotch plate reinforcement, such reinforcement shall be provided.

5. Outlets shall be fabricated so that there is always at least a 12-inch distance between the outer edge of the reinforcing plate and any field welded joints. For outlets without reinforcing plates, outlets shall penetrate the steel cylinders so that there is at least a 12-inch clearance between the outlet and any field welded joints.

F. Tees, wyes, crosses, elbows, and manifolds shall be fabricated so that the outlet clearances and reinforcing plates from any weld joints are a minimum of 5 times cylinder thickness or 2 inches, whichever is greater. Longitudinal weld joints in adjacent cylinder sections shall be oriented so that there is a minimum offset of 5 times cylinder thickness or 2 inches, whichever is greater.

G. Steel welding fittings shall conform to ASTM A 234 - Piping Fittings of Wrought Carbon Steel and Alloy Steel for Moderate and Elevated Temperatures.

H. Ends for Mechanical-Type Couplings: Except as otherwise indicated, where mechanical-type couplings are indicated, the ends of pipe shall be banded with Type C collared ends using double fillet welds. Where pipe 12-inch and smaller is furnished in standard schedule thicknesses, and where the wall thickness equals or exceeds the coupling manufacturer's minimum wall thickness, the pipe ends may be grooved

2.4 DESIGN OF PIPE AND SPECIALS

A. General: The pipe shall be steel pipe, lined and coated, with rubber gasketed or field welded joints as indicated. The pipe shall consist of a steel cylinder, either shop-lined or lined-in-place with portland cement-mortar or fusion bonded epoxy.

B. The pipe shall be designed, manufactured, tested, inspected, and marked according to applicable requirements previously stated and, except as hereinafter modified, shall conform to ANSI/AWWA C200.

C. Design: Except as otherwise indicated, materials, fabrication and shop testing of straight pipe shall conform to the requirements of ANSI/AWWA C200 - Steel Water Pipe 4 in and Larger, and shall conform to the dimensions of ANSI/AWWA C208 - Dimensions for Fabricated Steel Water Pipe Fittings. Unless otherwise noted in the Contract Documents, the minimum thickness of plate for pipe from which specials are to be fabricated shall be the greater of that determined by the following five criteria:

1. Working and Transient Pressure Design

$$T = \frac{P_w D/2}{Y/S_w} \qquad T = \frac{P_t D/2}{Y/S_t}$$

Where:

T	=	Steel cylinder thickness in inches
D	=	Outside diameter of steel cylinder in inches
P_w	=	Design working pressure in psi
P_t	=	Design transient pressure in psi
Y	=	Specified minimum yield point of steel in psi
S_w	=	Safety factor of 2.5 at design working pressure
S_t	=	Safety factor at design transient pressure; for elbows 1.875, and 2.0 for other specials

2. Mainline Pipe Thickness: Plate thickness for specials shall not be less than for the adjacent mainline pipe.

3. Thickness based on Pipe Diameter:

Nominal Pipe Diameter (in)	**Pipe Manifolds Piping Above Ground Piping Structures**	**Elbows Bends Reducers**
24 and under	3/16-in	Sch. 30
25 to 48	1/4-in	1/4-in
over 48	5/16-in	5/16-in

4. Specials installed on saddle supports shall be designed to limit the longitudinal bending stress to a maximum of 10,000 psi. Design shall be in accordance with the provisions of Chapter 7 of AWWA M-11.

5. For resistance to external load on buried pipe and for handling and transport, the thickness of the steel cylinder shall not be less than the thickness of adjacent mainline pipe or the cylinder thicknesses specified in the following table:

Nominal Pipe Diameter (in)	Minimum Cylinder Thickness at 95% Std. Proctor (in)	Cover Where Lean Concrete Encasement Required (ft)	Cover Where Reinf. Concrete Encasement Required (ft)
18 and under	0.1875	over 38	over 43
over 18 to 24	0.1875	over 22	over 27
over 24 to 36	0.250	over 15	over 20
over 36 to 48	0.250	over 11	over 17
over 48 to 60	0.3125	over 11	over 16
over 60 to 72	Nom. Diam./192	over 10	over 16

In no case shall the vertical deflection of the pipe exceed 1.5 percent of the nominal

diameter.

D. Minimum wall thickness shall include zero minus mill tolerances.

E. Fitting Dimensions: The fittings shall be of the diameter and class shown.

F. Joint Design: Unless indicated otherwise, the standard field joint for steel pipe shall be a rubber gasket joint. For buried steel pipe greater than 12-inches, field joints shall be welded lap joint (single). Welded joints shall be provided where indicated. Butt-strap joints shall be used only where required for closures or where shown.

G. Lap joints prepared for field welding shall be in accordance with ANSI/AWWA C200. The method used to form, shape, and size bell ends shall be such that the physical properties of the steel are not substantially altered. Unless otherwise approved by the Engineer, bell ends shall be formed by an expanding press or by being moved axially over a die in such a manner as to stretch the steel plate beyond its elastic limit to form a truly round bell of suitable diameter and shape. Faying surfaces of the bell and spigot shall be essentially parallel, but in no case shall the bell slope vary more than 2 degrees from the longitudinal axis of the pipe.

H. For bell-and-spigot ends with rubber gaskets, the clearance between the bells and spigots shall be such that when combined with the gasket groove configuration and the gasket itself, will provide watertight joints under all operating conditions when properly installed. The Contractor shall require the pipe manufacturer to submit details complete with significant dimensions and tolerances and also to submit performance data indicating that the proposed joint has performed satisfactorily under similar conditions. In the absence of a history of field performance, the results of a test program shall be submitted. Unless otherwise approved by the Engineer, bell ends shall be formed by an expanding press or by being moved axially over a die in such a manner as to stretch the steel plate beyond its elastic limit to form a truly round bell of suitable diameter and shape. No process will be permitted in which the bell is formed by rolling. Spiral weld seams shall be tested by the visible penetrant method of ASTM E 165 - Methods for Liquid Penetrant Inspection or magnetic particle inspection method of ASME Section VIII, Division 1, Appendix VI, for a minimum distance of 12 inches from each end of each joint after the spigot and bell are formed. Defects shall be repaired.

I. Shop-applied interior linings and exterior coatings shall be held back from the ends of the pipe as indicated or as otherwise acceptable to the Engineer.

J. Restrained Joints

1. Located where indicated, restrained joints shall be field-welded joints, either single, or inside and outside (double) lap-weld, or butt-weld, or butt-straps as indicated. Designs shall include stresses created by the greater of:

   a. Temperature differential of 40 degrees F plus Poisson's effect in combination with hoop stress, or;

   b. Thrust due to bulkheads, bends, reducers, and line valves resulting from working pressure in combination with hoop stress.

2. For field welded joints, design hoop stresses shall not exceed 18,000 psi. At the Contractor's option, the steel cylinder area may be progressively reduced from the point of maximum thrust to the end of the restrained length.

2.5 CEMENT-MORTAR LINING

A. Cement-Mortar Lining for Shop Application: Unless indicated otherwise, interior surfaces of all pipe and specials, shall be cleaned and lined in the shop with cement-mortar lining applied centrifugally in conformity with ANSI/AWWA C205. During the lining operation and thereafter, the pipe shall be maintained in a round condition by suitable bracing or strutting. The lining machines shall be of a type that has been used successfully for similar work and shall be approved by the Engineer. Every precaution shall be taken to prevent damage to the lining. If lining is damaged or found defective at the Site, the damaged or unsatisfactory portions shall be replaced with lining conforming to these Specifications at no additional cost to the Owner.

B. The minimum lining thickness and tolerance shall be in accordance with ANSI/AWWA C205.

C. The pipe shall be left bare as indicated where field joints occur. Ends of the linings shall be left square and uniform. Feathered or uneven edges will not be permitted.

D. Defective linings, as determined by the Engineer, shall be removed from the pipe wall and shall be replaced to the full thickness required. Defective linings shall be cut back to a square shoulder in order to avoid feather-edged joints.

E. The progress of the application of mortar lining shall be regulated in order that all hand work, including the repair of defective areas is cured in accordance with the provisions of ANSI/AWWA C205. Cement-mortar for patching shall be the same materials as the mortar for machine lining, except that a finer grading of sand and mortar richer in cement shall be used when field inspection indicates that such mix will improve the finished lining of the pipe.

F. Cement-Mortar Lining for Field Application: The materials and design of in-place cement-mortar lining shall be in accordance with ANSI/AWWA C602 - Cement-Mortar Lining of Water Pipeline-4 in and Larger-Shop Applied. The minimum lining thickness and finished inside diameter shall be as indicated for shop-applied cement-mortar lining.

G. Protection of Pipe Lining/Interior: For all pipe and fittings with plant-applied or cement-mortar linings, the Contractor shall provide a polyethylene or other suitable bulkhead on the ends of the pipe and on all special openings to prevent drying out of the lining. All bulkheads shall be substantial enough to remain intact during shipping and storage until the pipe is installed.

H. The pipe lining shall have smooth dense interior surfaces and shall be free from fractures, excessive interior surface crazing, and roughness.

2.6 EXTERIOR MORTAR COATING OF PIPE

A. Exterior Mortar Coating of Exposed Piping: The exterior surfaces of pipe which will be exposed to the atmosphere inside structures or above ground shall be thoroughly cleaned and then given a shop coat of primer compatible with the finish coating required by Section 09900 – Painting and Coatings.

B. Exterior Coating of Buried Piping: All pipe and specials for buried service, including bumped heads, shall be coated with a 1-inch minimum thickness of reinforced cement-mortar coating. Unless otherwise indicated, exterior surfaces of pipe, specials or

fittings passing through structure walls shall be cement-mortar coated from the center of the wall or from the wall flange, if indicated, to the end of the underground portion of pipe or fitting. The coating shall be reinforced with a spiral wire reinforcement or welded wire fabric in accordance with ANSI/AWWA C205. The welded wire fabric shall be securely fastened to the pipe with welded clips or strips of steel. The wire spaced 2 inches on centers shall extend circumferentially around the pipe. The ends of reinforcement strips shall be lapped 4 inches and the free ends tied or looped to assure continuity of the reinforcement.

2.7 FUSION-BONDED EPOXY COATING AND LINING

A. General: Except as described below, the material system for the exterior and interior of steel pipe and fittings installed underground or underwater shall be in accordance with ANSI/AWWA C213.

B. Minimum Pipe Diameter: The minimum pipe diameter for application of an internal lining shall be 6 inches for welded joint pipe, and 4 inches for gasketed joint pipe.

C. Maximum Temperature: This material system shall be able to withstand a maximum service temperature of 190° F.

D. Thickness: The powder shall be applied to the preheated pipe at a uniform cured thickness. The minimum nominal uniform cured thickness of the applied material shall be as follows:

1. Interior, 16 mils minimum

2. Exterior, 14 mils minimum

3. Maximum thickness shall be determined by the applicator based on the roughness of the pipe so as to obtain a holiday free product. Lining and coating thickness for pipe joints shall be compatible with dimensional tolerances.

E. Field-Welded Joints: The repair of field-welds shall be per Section 3.5 of ANSI/AWWA C213, EXCEPT that Subsection 3.5.3 shall not be used for the internal repair. After joint repair the joint shall be tested for continuity per Subsection G.2 below.

F. Blast Cleaning: The pipe surfaces to be covered in the plant shall be blast-cleaned with steel grit to achieve a near white surface conforming to SSPC-SP10 per 09900 – Painting and Coatings.

G. Continuity Tests:

1. Interior of pipe shall be electrically inspected for continuity at 2100 volts. At the option of the CONSTRUCTION MANAGER, if the number of holidays exceeds one per 3 linear feet of pipe 20 inches O.D. or smaller, or one per 2 linear feet of pipe over 20 inches O.D., the pipe shall be reprocessed. If not reprocessed, all defects disclosed by the holiday detector shall be repaired in the shop according to Subsection 3.4 - Coating Repair of the ANSI/AWWA C213 specifications.

2. Exterior of pipe shall be electrically inspected for continuity at 1965 volts. At the option of the CONSTRUCTION MANAGER, if the number of holidays exceeds one per 3 linear feet of pipe length for pipe smaller than 14 inches O.D., or one per 25 square feet of surface area for pipe 14 inches in O.D. and larger, the pipe

shall be reprocessed. If not reprocessed, all defects disclosed by the holiday detector shall be repaired in the shop according to Subsection 3.4 - Coating Repair of the ANSI/AWWA C213 specifications.

3. Coating Repair and Field Touch-Up: If gasketed joint pipe is used, exothermic weld connections for the installation of bond cables across joints of the pipeline for cathodic protection shall be repaired and touched-up with 3M-312 material or equal.

2.8 PIPE APPURTENANCES

A. Pipe appurtenances shall be in accordance with the requirements of Division 15 of the Specifications. Access manholes with covers shall be as indicated, installed during fabrication, not in the field. Threaded outlets shall be forged steel suitable for 3000 psi service, and shall be as manufactured by Vogt, or equal.

PART 3 EXECUTION

3.1 DELIVERY AND STORAGE

A. All pipe specified under this Section shall be handled according to the provisions of Section 02500 – Buried Pipe Installation.

B. Pipe struts shall be left in place until backfilling operations have been completed for pipe 42 inches in diameter and larger. Struts in pipe smaller than 42 inches may be removed immediately after laying. A laboratory selected and paid by the Owner may monitor pipe deflection by measuring pipe inside diameter before struts are removed and 24 hours after struts are removed. Pipe deflection shall not exceed 1.25 percent 24 hours after the struts are removed. After the backfill has been placed, the struts shall be removed and shall remain the property of the Contractor. For mortar-lined or mortar-coated steel pipe, the following requirements shall apply:

1. The strutting shall be placed as soon as practicable after the mortar lining has been applied and shall remain in place while the pipe is loaded, transported, unloaded, installed, and backfilled at the jobsite.

2. The strutting materials, size and spacing shall be adequate to support the earth backfill plus any greater loads which may be imposed by the backfilling and compaction equipment.

3. Any pipe damaged during handling, hauling, storage, or installation due to improper strutting shall be repaired or replaced.

3.2 INSTALLATION OF PIPE

A. Joints

1. Rubber Gaskets

a. Rubber Gasketed Joints: Immediately before jointing pipe, the spigot end of the pipe shall be thoroughly cleaned, and a clean rubber gasket lubricated with an approved vegetable-based lubricant shall be placed in the spigot groove. The lubricant shall be a compound listed as in compliance with NSF

Standard 61. The volume of the gasket shall be "equalized" by moving a metal rod between the gasket and the spigot ring around the full circumference of the spigot ring. The bell of the pipe already in place shall be carefully cleaned and lubricated with the vegetable-based lubricant. The spigot of the pipe section shall then be inserted into the bell of the previously laid joint and telescoped into its proper position. Tilting of the pipe to insert the spigot into the bell will not be permitted. After the pipe units have been joined, a feeler gage shall be inserted into the recess and moved around the periphery of the joint to detect any irregularity in the position of the rubber gasket. If the gasket cannot be "felt" all around, the joint shall be disassembled. The joint shall be reassembled with a new gasket.

2. Welded Joints

   a. Welded joints shall be provided where indicated.
   b. General: Field welded joints shall be in accordance with ANSI/AWWA C206 - Field Welding of Steel Water Pipe.
   c. During installation of welded steel pipe in either straight alignment or on curves, the pipe shall be laid so that, at any point around the circumference of the joint, there is a minimum lap of 1/2-inch and a minimum space of 3/4-inch plus the thickness of the steel pipe wall between the spigot end of the pipe and the nearest tangent to a bell radius.
   d. Where exterior welds are performed, adequate space shall be provided for welding and inspection of the joints.
   e. Butt straps shall be as indicated, shall be a minimum of 6 inches wide, the same thickness as the pipe wall, and shall provide for a minimum 2-inch lap at each pipe joint.
   f. After the pipe and joint are properly positioned in the trench, the length of pipe between joints shall be backfilled to at least one foot above the top of the pipe. Care shall be exercised during the initial backfilling to prevent movement of the pipe and to prevent any backfill material from being deposited on the joint.
   g. To control temperature stresses, the unbackfilled joint areas of the pipe shall be shaded from the direct rays of the sun by the use of properly supported awnings, umbrellas, tarpaulins, or other suitable materials for a minimum period of 2 hours prior to the beginning of the welding operation and until the weld has been completed. Shading materials at the joint area shall not rest directly on the pipe but shall be supported to allow air circulation around the pipe. Shading of the pipe joints need not be performed when the ambient air temperature is below 45 degrees F.
   h. Shrinkage Control Joints: At intervals not exceeding 250 feet along welded reaches of the pipeline and at the first regular lap-welded field joints outside concrete encasements and structures, the pipe shall be laid with an initial lap of not less than 1-inch greater than the minimum lap dimension. The welding of each such shrinkage control joint shall be performed when the temperature is approximately the lowest during the 24-hour day, after at least 250 feet of pipe have been laid and the joints have been welded ahead of and in back of the shrinkage control joint, and after backfill has been completed to at least 1-foot above the top of the pipe ahead of and in back of the shrinkage control joint. Where shrinkage control joints occur in a traveled roadway or other inconvenient location, the location of the shrinkage control joint may be adjusted, as acceptable to the Engineer.

i. Prior to the beginning of the welding procedure, any tack welds used to position the pipe during laying shall be removed. Any annular space between the faying surfaces of the bell and spigot shall be equally distributed around the circumference of the joint by shimming, jacking, or other suitable means. The weld shall then be made in accordance with ANSI/AWWA C206. Where more than one pass is required, all dirt, slag, and flux shall be removed before the succeeding bead is applied.

j. Prior to butt welding, the pipe and joint shall be properly positioned in the trench using line up clamps so that, in the finished joint, the abutting pipe sections shall not be misaligned more than 1/16-inch.

k. Joints: The pipe ends shall be cut straight on joints where butt straps are used for realignment, adjustment, or deflection, and fillet welds shall be made as indicated.

l. Unless double fillet welds are shown on the Drawings, field welded lap joints may, at the Contractor's option, be made on either the inside or the outside of the pipe.

m. Inspection of Field Welded Joints: An independent testing laboratory acceptable to the Engineer but paid by the Contractor at no increased cost to the Owner shall inspect the joints. Inspection shall be as soon as practicable after the welds are completed.

1) Fillet welds shall be tested by the Magnetic Particle Inspection Method in accordance with ASME Section VIII, Division 1, Appendix VI.

2) In addition, double fillet welds on butt strap joints shall be tested by the soap solution method using approximately 40 psi air pressure introduced between the plates through a threaded hole as indicated. Test holes shall be plugged by a threaded plug or welding following successful testing.

3) Butt welds shall be inspected by radiographic methods in accordance with API Standard 1104.

3. Joint Mortar Coating and Mortar Lining

a. Pipe and Specials Protection: The Contractor shall introduce water into the pipe to keep the mortar moist where moisture has been lost due to damaged bulkheads.

b. Following tests of the joint, the exterior joint spaces shall be coated in accordance with these specifications after which backfilling may be completed.

c. Where butt-straps or closure pieces are used, both the interior and exterior surfaces of the butt-straps or closure pieces shall be given a coating equivalent to the factory-applied coating of the adjoining pipe sections. Any exterior cement mortar coating in such cases shall be reinforced with wire mesh. Any interior cement mortar lining shall be similarly reinforced, where the exposed length of the butt-straps or closure piece, as measured between the ends of connected pipe sections, exceeds 4 inches.

d. General: The interior and exterior joint recesses shall be thoroughly wiped clean and all water, loose scale, dirt, and other foreign material shall be removed from the inside surface of the pipe. The grout for joint coating and lining shall be cement grout in accordance with Section 03600 – Grouts, except that composition shall be one part cement to two parts sand and

sufficient water for dry-pack consistency for joint linings and thick cream consistency for joint coatings.

e. Joint Coating: After the pipe has been laid and after sufficient backfill has been placed between the joints to hold the pipe securely in place, the outside annular space between pipe sections shall be completely filled with grout formed by the use of polyethylene foam-lined fabric bands. The grout space shall be flushed with water prior to filling so that the surface of the joint to be in contact with the grout will be thoroughly moistened when the grout is poured. The joint shall be filled with grout by pouring from one side only, and shall be rodded with a wire or other flexible rod or vibrated so that the grout completely fills the joint recess by moving down one side of the pipe, around the bottom of the pipe and up the opposite side. Pouring and rodding the grout shall be continued to allow completion of the filling of the entire joint recess in one operation. Care shall be taken to leave no unfilled space. Grouting of the outside joint spaces shall be kept as close behind the laying of the pipe as possible except that in no case shall grouting be closer than 3 joints of the pipe being laid.

f. Similarly, in the case of mortar-coated pipe, after the coupled or flanged joint is completed, the coupling, flange, or bare metal of the pipe shall be cleaned, primed, and coated with a minimum thickness of 1-inch of cement mortar, having one part cement to not more than 2 parts plaster sand.

g. Grout Bands (Diapers): The grout bands or heavy-duty diapers shall be polyethylene foam-lined fabric with steel strapping of sufficient strength to hold the fresh mortar, resist rodding of the mortar, and allow excess water to escape. The foam plastic shall be 100 percent closed cell, chemically inert, insoluble in water and resistant to acids alkalies and solvents, and shall be Dow Chemical Company, Ethafoam 222, or equal.

h. The fabric backing shall be cut and sewn into 9-inch wide strips with slots for the steel strapping on the outer edges. The polyethylene foam shall be cut into strips 6 inches wide and slit to a thickness of 1/4-inch which will expose a hollow or open cell surface on one side. The foam liner shall be attached to the fabric backing with the open or hollow cells facing towards the pipe. The foam strip shall cover the full interior circumference of the grout band with sufficient length to permit an 8-inch overlap of the foam at or near the top of the pipe joint. Splices to provide continuity of the material will be permitted. The polyethylene foam material shall be protected from direct sunlight.

i. The polyethylene foam-lined grout band shall be centered over the joint space with approximately equal widths extending over each pipe end and securely attached to the pipe with the steel straps. After filling the exterior joint space with grout, the flaps shall be closed and overlapped in a manner that fully encloses the grout with polyethylene foam. The grout band shall remain in position on the pipe joint.

j. Joint Lining: After the backfill has been completed to final grade, the interior joint recess shall be filled with grout. The grout for joint coating and lining shall be cement grout in accordance with Section 03600 – Grout, except that composition shall be one part cement to two parts sand and sufficient water for dry-pack consistency. The grout shall be tightly packed into the joint recess and troweled flush with the interior surface. All excess shall be removed. At no point shall there be an indentation or projection of the mortar exceeding 1/16-inch. With pipe smaller than 24 inches in diameter, before the spigot is inserted into the bell, the bell shall be daubed with grout

containing one part cement to two parts sand. The joint shall be completed and excess mortar on the inside of the joint shall be swabbed out.

k. Cement-Mortar Lining, Field-Applied: For pipe diameters of 60 in or larger, the Contractor may construct the cement-mortar lining in-place. The application of in-place cement-mortar lining shall be in accordance with ANSI/AWWA C602.

l. The lining machine shall be of a type that has been used successfully for a similar size of pipe. The Contractor shall perform all work in a thorough and workmanlike manner by trained personnel under the supervision of experienced personnel skilled in machine application of cement-mortar lining to pipelines of size comparable to this Work.

1) Curing of the in-place cement-mortar lining shall be in accordance with ANSI/AWWA C602. The Contractor shall provide additional protective devices as required to ensure that the airtight covers, which maintain a moist condition in the pipeline, are not damaged.

2) Defective areas encompassing the full circumference of the pipe shall be replaced by machine wherever the length measured along the pipe centerline is greater than 5 feet; otherwise defective areas may be replaced by hand.

3.3 TESTING

A. Testing of lined and coated pipe shall be in accordance with Section 02500 – Buried Pipe Installation, Section 02640 – Pipeline Testing and Disinfection, referenced standards and the additional requirements in this Section.

B. Where required by the Engineer, all pipe, 36 inches in diameter and larger, which has been installed and backfilled to the minimum required compaction, shall be tested by the Contractor in the presence of the Engineer to insure that the vertical deflections for welded steel pipe do not exceed the maximum allowable deflection specified. Deflection tests shall be performed not sooner than 30 days after completion of placement and densification of backfill and removal of pipe struts, if any. The Contractor shall submit to the Engineer for acceptance, the method proposed to determine the deflections. Unless otherwise permitted by the Engineer, any overdeflected pipe shall be uncovered and, if not damaged, reinstalled. Damaged pipe shall not be reinstalled but shall be removed from the jobsite. Any pipe subjected to any method or process other than removal, which attempts, even successfully, to reduce or cure any over deflection, shall be uncovered, removed from the jobsite, and replaced with new pipe. All costs incurred by the Contractor attributable to deflection testing, including any delays, shall be borne by the Contractor at no cost to the Owner.

C. Repair of Welds: All welds that are defective shall be repaired by the Contractor to meet the requirements of the applicable sections of these specifications at no additional cost to the Owner. Defects in welds or defective welds shall be removed, and that section of the joint shall then be rewelded. Only sufficient removal of defective material that is necessary to correct the defect is required. After the repair is made, the joint shall be checked by repeating the original test procedure. Welds deficient in size shall be repaired by adding weld metal.

3.4 INSTALLATION OF PIPE APPURTENANCES

A. Protection of Appurtenances: Where the joining pipe is concrete or coated with cement mortar, buried appurtenances shall be coated with a minimum thickness of one inch of cement mortar having one part cement to not more than 2 parts plaster sand.

B. Insulated Joints: Insulated joints and appurtenant features shall be provided as indicated. The Contractor shall exercise special care when installing these joints to prevent electrical conductivity across the joint. After the insulated joint is completed, an electrical resistance test shall be performed by the Contractor. Should the resistance test indicate a short circuit, the Contractor shall remove the insulating units to inspect for damage, replace all damaged portions, and reassemble the insulating joint. The insulated joint shall then be retested to assure proper insulation.

3.5 CORROSION CONTROL

A. Joint Bonding/Electrolysis Test Stations: Except where otherwise indicated, all gasketed joints shall be bonded in accordance with the Drawings. The pipe shall be cleaned to bare bright metal at the point where the bond is installed. In addition, electrolysis test stations shall be installed where indicated.

END OF SECTION

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SECTION 02590– HIGH DENSITY POLYETHYLENE PRESSURE PIPE

PART 1 GENERAL

1.1 THE REQUIREMENT

A. The CONTRACTOR shall furnish and install all High Density Polyethylene (HDPE) pressure pipe and all appurtenant work, complete in place, including connection to existing and new structures, all in accordance with the requirements of the Contract Documents.

B. All pipe specified under this Section shall conform to the requirements of Section 02500 – Buried Pipe Installation.

1.2 REFERENCE SPECIFICATIONS, CODES, AND STANDARDS

A. Codes: All work specified herein shall conform to the requirements of all applicable codes and regulations.

B. ASTM

C. AWWA

D. ASME

E. ANSL

F. NFPA

1.3 CONTRACTOR SUBMITTALS

A. Shop Drawings: The CONTRACTOR shall submit Shop Drawings of pipe, fittings, and appurtenances in accordance with the requirements in Section 01340 - Shop Drawings, Product Data and Samples, Section 02500 – Buried Pipe Installation, the requirements of the referenced standards and the following supplemental requirements.

1. Shop drawings and descriptive literature showing pipe dimensions, joints, and other details for each size of pipe indicated.

2. Certification from manufacturer with each delivery that pipe complies with this specification.

3. Certified copies of test reports with each delivery, stated compliance with ASTM F714 and ASTM D3350 as appropriate.

4. If the CONTRACTOR proposes any deviations from the design alignment, for example using a curve instead of a fitting where a PI or VPI is shown, appropriate information must be submitted, including manufacturer's recommended minimum allowable bend radius of pipe. The ENGINEER reserves the right to require a larger minimum radius.

5. Pipe manufacturers' joint assembly procedure including cool down time and datalogger equipment.

6. HDPE Fusion Technician's experience and qualifications. Submit written certification from the HDPE pipe fusion equipment supplier that the fusion technician has received training in the proper use of the fusion equipment and the manufacturer's recommended fusion equipment.

7. Description of pressure and leakage test procedures to be used. Description of all testing equipment to be used during pressure and leakage testing.

8. Manufacturer's written Quality Assurance/Quality Control Program.

9. Certified dimensional drawings of all valves, fittings and appurtenances.

B. Samples

1. Wall Uniformity Samples: The purpose of these samples is to visually check wall uniformity to determine if the HDPE resin pellets fully melted during the extrusion process.

a. The OWNER will select 5 sticks from the total number of sticks of each size and DR delivered to the project which to obtain a sample from.

b. Each sample will be five feet long and will come from the end of the pipe.

c. After the OWNER selects a sample, the CONTRACTOR shall cut the sample from the pipe and load the sample onto the OWNER's truck.

d. The exposed cross-section will be examined for uniform color, appearance, consistency, and other properties.

e. The samples will be stored for future testing if needed.

C. Certifications: The CONTRACTOR shall furnish a certified affidavit of compliance to the ENGINEER guaranteeing that the pipe and other products or materials furnished hereunder is in compliance with the requirements of these Specifications and the reference standards.

D. All expenses incurred in making samples for certification of tests shall be borne by the CONTRACTOR at no increased cost to the OWNER.

1.4 QUALITY ASSURANCE

A. Inspection: All pipe shall be subject to inspection at the place of manufacture in accordance with the requirements of the applicable referenced standards as supplemented by the requirements herein. The CONTRACTOR shall notify the ENGINEER in writing of the manufacturing starting date not less than 14 calendar days prior to the start of any phase of the pipe manufacture.

B. During the manufacture of the pipe, the ENGINEER shall be given access to all areas where manufacturing is in process and shall be permitted to make all inspections necessary to confirm compliance with the Specifications

C. Tests: Unless otherwise specified, all material used in the manufacture of the pipe shall be tested in accordance with the requirements of the applicable referenced standards.

D. The CONTRACTOR shall perform all material tests at no additional costs to the OWNER. The ENGINEER shall have the right to witness all testing conducted by the CONTRACTOR provided that the CONTRACTOR's schedule is not delayed for the convenience of the ENGINEER. In addition to those tests specifically required, the ENGINEER may request additional samples of any material for testing by the OWNER. The additional samples shall be furnished at no additional cost to the OWNER.

E. HDPE Fusion Technician

1. Technician making fusion bonded joints shall be employed or trained by the fusion equipment manufacturer.

2. The technician making the fusion bonded joints shall have the following minimum experience:

a. Performed fusion bonding on at least three prior projects
b. Performed fusion bonding on at least 5,000 feet of 6-inch (or larger) HDPE pipe.

F. HDPE Fusion Measurements

1. Fusion machine heater plate surface temperatures and hydraulic cylinder interface pressures shall be recorded during the butt-fusion joining operations. Measurements shall be permanently recorded utilizing a McElroy Datalogger or OWNER-approved equal.

2. Recorded fusion data shall be submitted to the OWNER within two days following the completion of any joint. Failure to submit this information may result in the joint being rejected and replaced.

PART 2 PRODUCTS

2.1 PIPE

A. Pipe shall be high molecular weight, high density polyethylene pipe (HDPE).

B. Pipe Material Designations

1. Pipe material for all service shall be listed by the Plastic Pipe Institute (PPI) with a designation of PE 3408 and have a minimum cell classification of 345464C, D or E as described in ASTM D3350. The pipe shall have wall thickness as prescribed in the Pipe Schedule.

C. The pipe material shall meet the requirements for Type III, Class B, Category 5, Grade P34 material as described in ASTM D1248.

D. The pipe shall contain no recycled compound except that generated in the manufacturer's own plant from resin of the same specification from the same raw pipe material.

E. Pipe installed above grade, shall be black pipe (containing 2.0% minimum carbon black) and coating in accordance with 09900 - Painting and Coatings.

F. Pipe and fittings shall be made in conformance with ASTM F714 and ASTM D3261 as modified for the specified material.

G. The pipe shall be homogeneous throughout and free of cracks, holes, foreign inclusions or other injurious defects. It shall be uniform in density and other physical properties.

H. Any pipe not meeting these criteria shall be rejected and taken from the site.

I. Pipe shall conform to the nominal sizes and standard dimension ratios shown on the Pipe Schedule (see Drawings).

J. Manufacturers, or Equal

1. CP Chem (Chevron Phillips Chemical Company). Represented by P&F Distributors.

2. Rinker Materials. Represented by Maskell-Robbins.

3. Quail Pipe Corporation. Represented by Maskell-Robbins.

4. KWH Pipe Corporation.

2.2 JOINTS

A. General

1. Joints shall be butt fusion joints, socket fusion joints, flanged joints, or electro-fusion joints. Friction or pressure couplings are not acceptable, unless specifically noted otherwise.

B. Butt Fusion Joints

1. Butt fusion techniques shall meet all requirements of ASTM D2657 and D3261.

2. Butt fusion between pipes that are more than two DR steps different is not allowed. A transition fitting shall be required to connect pipes more than two DR steps different. A transition fitting shall be a short plain pipe with one end taper bored to match the thinner walled pipe. For example, to connect DR 11 and DR 21 pipe, a plain piece of DR 11 pipe with one end taper bored to DR 21 shall be used.

C. Socket Fusion Joints

1. Socket fusion techniques shall meet all requirements of ASTM D2657.

2. Socket fusion equipment shall meet all requirements of ASTM F1056.

D. Flanged Joints

1. All flanged joints shall consist of HDPE flange adaptors and backup rings.

2. Full face flat ring gaskets of 1/8-inch black reinforced rubber conforming to ANSI B-16.21 shall be installed between the opposing ends of the flange adapters. Gaskets shall have bolt holes and be held in position by the bolts.

3. All backup rings (flanges) shall be polypropylene encapsulated ductile iron.

4. Backup rings shall meet the pressure class of the pipe.

5. Bolt sets shall conform to the requirements of Section 02500 – Buried Pipe Installation

E. Mechanical Connections

1. Mechanical connections may be used where indicated on the Contract Drawings.

2. Mechanical connections shall conform to the requirements of Section 15000 and shall be specifically approved for use by on HPDE pipe by the HDPE pipe manufacturer.

3. All mechanical connections shall be full restrained to prevent pipe pull-out at the rated pressure of the pipe.

4. Pipe stiffeners shall be used where recommended by the HDPE pipe manufacturer.

2.3 FITTINGS

A. Fittings shall be polyethylene fabricated fittings and shall meet the following requirements.

1. All fittings shall be either molded or fabricated in accordance with AWWA C906.

2. All fittings shall have the same SDR as the pipe they are used on.

3. All fittings shall be fabricated from the same polyethylene material as the pipe.

4. All fittings shall be fully pressure rated and meet requirements for AWWA C906.

5. Reinforced fittings (fiberglass wrapped for example) are not allowed.

6. All fittings shall have taper bored ends to meet adjoining pipe wall thickness.

7. All elbows shall be sweep elbows. For example, all 90 degree elbows shall be 5-segment elbows and all 45 degree elbows shall be 3-segment elbows.

8. All fittings shall be pressure tested to four times working pressure of pipe for five seconds or alternative back-bend test as provided for in AWWA C906.

B. Polyethylene flange adapters shall be made with sufficient through-bore length to be clamped in a butt-fusion machine without the use of a stub-end holder. The sealing surface of the flange adapter shall be machined with a series of small v-shaped grooves to restrain the gasket against blow-out.

PART 3 EXECUTION

3.1 DELIVERY AND STORAGE

A. All pipe specified under this Section shall be handled according to the provisions of Section 02500 – Buried Pipe Installation.

B. Pipe shall be delivered in 40-foot lengths or longer but not longer than can be transported over highways. This is required to minimize field construction time and to maximize the control over the environmental conditions that affect the fusion processes and thereby the ultimate quality of the completed joint.

3.2 INSTALLATION

A. Pipe sections with gouges or cuts deeper than 10% of the wall thickness shall be cut out and removed and replaced by the CONTRACTOR at no additional cost to the OWNER. Undamaged pipe portions shall be rejoined using butt-fusion joining methods.

B. Butt Fusion and Socket Fusion Joining

1. Clean joint surfaces: Prepare joint surfaces according to manufacturer's recommendations. Use devices to force pipes together with minimum open recess inside and outside and tightly seal joints. Avoid forces that could wedge apart and split ends.

2. Do not pull or cramp joints without permission of ENGINEER.

3. Remove unfittable pipes and replace with sound units.

C. After bedding pipe, place and compact bedding between pipe and sides of trench. Compact bedding under lower half of pipe. Place and compact bedding as indicated and in conformance with Section 02200 – Earthwork.

3.3 TESTING

A. General

1. Inspect each pipe and fitting prior to fusion of the joints. Remove defective pipes from the site.

2. Wall Uniformity Samples shall be obtained as described in Part 1.3 of this Section.

B. Hydrostatic testing, including test pressure and duration, of the HDPE pipe shall be in accordance with the requirements of Section 02640 – Pipeline Testing and Disinfection and this Section.

C. Allowances for expansion under test pressure for a 3-hour test duration is shown in the table below. Allowance only apply to the test phase and not to the initial filling and achieving equilibrium.

Nominal Pipe Size (inches)	Allowance of Expansion (gallons per 100 feet of pipe)
2	0.19
4	0.4
6	0.9
8	1.5
10	2.1
12	3.4
14	4.2
16	5
18	6.5
20	8
24	13.3
30	19.2
36	
48	
54	
60	

END OF SECTION

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SECTION 02595 – POLYVINYL CHLORIDE NON-PRESSURE PIPE, RUBBER JOINTS (ASTM D3034 AND F679, MODIFIED)

PART 1 GENERAL

1.1 THE REQUIREMENT

A. The Contractor shall furnish and install all polyvinyl chloride (PVC) non-pressure pipe and all appurtenant work, complete in place, including connection to existing and new structures, all in accordance with the requirements of the Contract Documents.

B. All pipe specified under this Section shall conform to the requirements of Section 02500 – Buried Pipe Installation.

1.2 REFERENCE SPECIFICATIONS, CODES, AND STANDARDS

A. Codes: All work specified herein shall conform to the requirements of all applicable codes and regulations.

1.3 CONTRACTOR SUBMITTALS

A. Shop Drawings: The Contractor shall submit Shop Drawings of pipe, fittings, and appurtenances in accordance with the requirements in Section 01340 Shop Drawings, Product Data and Samples, Section 02500 – Buried Pipe Installation, the requirements of the referenced standards and the following supplemental requirements.

1. Material lists that describe all materials to be utilized.

2. Design calculations for wall thickness or pressure class for all pipe whose thickness or pressure class is not specifically defined and for all restrained joint length requirements not specifically defined.

3. Manufacturer's written Quality Assurance/Quality Control Program.

4. Certified dimensional drawings of all valves, fittings and appurtenances.

B. Samples: The Contractor shall submit to the Engineer for approval, samples of all the materials proposed for use on the Work. The samples shall be clearly marked to show the manufacturer's name and product identification and shall be submitted along with the manufacturer's technical data and application instructions. All sampled submittals shall conform to the requirements in Section 01340 - Shop Drawings, Product Data and Samples.

C. Certifications: The Contractor shall furnish a certified affidavit of compliance to the Engineer guaranteeing that the pipe and other products or materials furnished hereunder is in compliance with the requirements of these Specifications, the reference standards and the following supplemental requirements:

1. Sustained pressure test reports.

2. Burst strength test reports.

3. Physical and chemical properties for the material components of all pipe, specials and appurtenances.

4. Hydrostatic test reports for pipe and rubber gaskets, where applicable.

5. Crushing test reports for samples taken from the center of full length sections of pipe.

6. Flattening resistance, impact resistance and stiffness test reports.

7. Rubber gasket tests, as applicable.

D. All expenses incurred in making samples for certification of tests shall be borne by the Contractor at no increased cost to the Owner.

1.4 QUALITY ASSURANCE

A. Inspection: All pipe shall be subject to inspection at the place of manufacture in accordance with the requirements of the applicable referenced standards as supplemented by the requirements herein. The Contractor shall notify the Engineer in writing of the manufacturing starting date not less than 14 calendar days prior to the start of any phase of the pipe manufacture.

B. During the manufacture of the pipe, the Engineer shall be given access to all areas where manufacturing is in process and shall be permitted to make all inspections necessary to confirm compliance with the Specifications

C. Tests: Unless otherwise specified, all material used in the manufacture of the pipe shall be tested in accordance with the requirements of the applicable referenced standards.

D. The Contractor shall perform all material tests at no additional costs to the Owner. The Engineer shall have the right to witness all testing conducted by the Contractor provided that the Contractor's schedule is not delayed for the convenience of the Engineer. In addition to those tests specifically required, the Engineer may request additional samples of any material for testing by the Owner. The additional samples shall be furnished at no additional cost to the Owner.

PART 2 PRODUCTS

2.1 GENERAL

A. All PVC pipe, in compliance with this Specification, shall be continuously and permanently marked with the manufacturer's name and code, pipe size, PVC minimum cell classification, pipe stiffness classification, pressure rating in psi, and ASTM designation where applicable.

B. The manufacturer's code shall include the year, month, day, shift, plant and extruder of manufacture. This coding shall be done in conjunction with records to be held by the manufacturer for 2 years, covering quality control tests, raw material batch number and other information deemed necessary by the manufacturer.

2.2 PIPE

A. All PVC pipe shall be joined by compression joints unless otherwise shown or specified and shall conform to the following requirements:

1. Polyvinyl chloride (PVC) shall conform to the requirements of ASTM D3034 or F679, as applicable, Class SDR 35. Material for PVC pipe shall conform to the requirements of ASTM D1784 for Class 12454-B, 12454-C or 12364-C as defined therein. Maximum filter content shall be 10 percent.

2. Rubber gaskets or elastomeric seals for compression type joints for PVC pipe and fittings shall conform to the requirements of ASTM D3212 or ASTM F477 as applicable.

2.3 FITTINGS

A. All fittings for PVC pipe shall conform to the requirements of ASTM D3034 or ASTM F679, as applicable. The ring groove and gasket ring shall be compatible with PVC pipe ends. The flanged fittings shall be compatible with cast-iron or ductile iron pipe fittings.

B. The strength class, stiffness or wall thickness of any fitting shall not be less than the strength class, stiffness or wall thickness of any adjoining pipe or of pipe of an equivalent size.

2.4 BEDDING MATERIAL

A. Unless otherwise specified or shown, all material used for pipe bedding shall conform to the requirements for “Embedment Materials” as specified in ASTM D2321 and the requirements of Section 02200 - Earthwork.

2.5 FLEXIBLE COUPLINGS

A. Flexible couplings shall be rubber, full-circle, clamp-on type conforming with ASTM C425 and provided with two stainless steel band screw clamps to secure the coupling tightly to entering and exiting pipes. All screw-clamp hardware shall be Type 316 stainless steel. Rubber material shall be suitable for sewage service.

PART 3 EXECUTION

3.1 DELIVERY AND STORAGE

A. All pipe specified under this Section shall be handled according to the provisions of Section 02500 – Buried Pipe Installation.

B. Storage: Pipe should be stored, if possible, at the job site in unit packages provided by the manufacturer. Caution should be exercised to avoid compression damage or deformation to bell ends of the pipe. Pipe should be stored in such a way as to prevent sagging or bending and protected from exposure to direct sunlight by covering with an opaque material while permitting adequate air circulation above and around the pipe. Gaskets should be stored in a cool, dark place out of the direct rays of the run, preferably in original cartons.

3.2 INSTALLATION

A. Installation shall conform to the requirements of ASTM D2321 and to the supplementary requirements specified herein. Wherever the provisions of this Section and the requirements of ASTM D2321 are in conflict, the more stringent provision shall apply.

3.3 LAYING PIPE

A. The pipe shall be installed in accordance with the requirements of ASTM D2321 and as specified herein and shown and the sections shell be closely jointed to form a smooth flow line.

B. Cutting and machining of the pipe shall be accomplished in accordance with the pipe manufacturer's standard procedures for this operation. Pipe shall not be cut with a cold chisel, standard iron pipe cutter not any other method that may fracture the pipe or will produce ragged, uneven edges.

3.4 FIELD JOINTING

A. Each pipe compression type joint shall be joined with a lock-in rubber ring and ring groove that is designed to resist displacement during pipe installation.

B. The ring and ring seat inside the bell shall be wiped clean before the gasket is inserted. At this time a thin film of lubricant shall be applied to the exposed surface of the ring and to the outside of the clean pipe end. Lubricant other than that furnished with the pipe shall not be used. The end of the pipe shall then be forced into the ring to complete the joint.

C. The pipe shall not be deflected either vertically or horizontally in excess of the printed recommendations of the manufacturer of the coupling.

3.5 ANCHOR BLOCKS

A. Anchor blocks shall be installed in accordance with the details shown.

3.6 TESTING

A. Mandrel testing: In addition to the requirements of Section 02640 – Pipeline Testing and Disinfection, all PVC gravity non-pressure pipe shall be tested for deflection and obstructions. The mandrel test shall be performed after backfilling and compacting but prior to final paving and prior to leakage testing. A rigid mandrel, with a circular cross section having a diameter of at least 97 percent of the base inside diameter, as defined in ASTM F679, shall be pulled through the pipe by hand. The minimum length of the circular portion of the mandrel shall be equal to the nominal diameter of the pipe. If the mandrel sticks in the pipe at any point, the pipe shall be repaired and retested.

END OF SECTION

SECTION 02597 – POLYVINYL CHLORIDE PRESSURE PIPE, RUBBER JOINTS

PART 1 GENERAL

1.1 THE REQUIREMENT

A. The CONTRACTOR shall furnish and install all polyvinyl chloride (PVC) pressure pipe and all appurtenant work, complete in place, including connection to existing and new structures, all in accordance with the requirements of the Contract Documents.

B. All pipe specified under this Section shall conform to the requirements of Section 02500 – Buried Pipe Installation.

1.2 REFERENCE SPECIFICATIONS, CODES, AND STANDARDS

A. Codes: All work specified herein shall conform to the requirements of all applicable codes and regulations.

1.3 CONTRACTOR SUBMITTALS

A. Shop Drawings: The CONTRACTOR shall submit Shop Drawings of pipe, fittings, and appurtenances in accordance with the requirements in Section 01340 - Shop Drawings, Product Data and Samples, Section 02500 – Buried Pipe Installation, the requirements of the referenced standards and the following supplemental requirements.

1. Material lists that describe all materials to be utilized.

2. Design calculations for wall thickness or pressure class for all pipe whose thickness or pressure class is not specifically defined and for all restrained joint length requirements not specifically defined.

3. Manufacturer's written Quality Assurance/Control Program.

4. Certified dimensional drawings of all valves, fittings, and appurtenances.

B. Certifications: The CONTRACTOR shall furnish a certified affidavit of compliance to the ENGINEER guaranteeing that the pipe and other products or materials furnished hereunder is in compliance with the requirements of these Specifications, the reference standards and the following supplemental requirements:

1. Sustained pressure test reports.

2. Burst strength test reports.

3. Physical and chemical properties for the material components of all pipe, specials and appurtenances.

4. Hydrostatic test reports for pipe and rubber gaskets, where applicable.

5. Rubber gasket tests, as applicable.

C. All expenses incurred in making samples for certification of tests shall be borne by the CONTRACTOR at no increased cost to the OWNER.

1.4 QUALITY ASSURANCE

A. Inspection: All pipe shall be subject to inspection at the place of manufacture in accordance with the requirements of the applicable referenced standards as supplemented by the requirements herein. The CONTRACTOR shall notify the ENGINEER in writing of the manufacturing starting date not less than 14 calendar days prior to the start of any phase of the pipe manufacture.

B. During the manufacture of the pipe, the ENGINEER shall be given access to all areas where manufacturing is in process and shall be permitted to make all inspections necessary to confirm compliance with the Specifications.

C. Tests: Unless otherwise specified, all material used in the manufacture of the pipe shall be tested in accordance with the requirements of the applicable referenced standards.

D. The CONTRACTOR shall perform all material tests at no additional costs to the OWNER. The ENGINEER shall have the right to witness all testing conducted by the CONTRACTOR provided that the CONTRACTOR's schedule is not delayed for the convenience of the ENGINEER. In addition to those tests specifically required, the ENGINEER may request additional samples of any material for testing by the OWNER. The additional samples shall be furnished at no additional cost to the OWNER.

PART 2 PRODUCTS

2.1 GENERAL

A. PVC pressure pipe shall conform to the applicable requirements of ANSI/AWWA C900 and C905 and the additional requirements specified herein.

2.2 PIPE DESIGN CRITERIA

A. General: PVC pressure pipe shall be designed in accordance with the requirements of AWWA Manual M23, as applicable, and the supplemental requirements specified in this Section.

B. Minimum Wall Thickness (DR): The minimum wall thickness DR for PVC pressure pipe shall be DR 18. Where service designation is for high pressure (150 psi up to 200 psi), minimum wall thickness DR shall be DR 14. The pipe pressure classification shall be derated for service temperature exceeding 77 degrees F as provided for in AWWA C900 and C905.

C. Pipe Wall Thickness for Internal Pressure: The pipe shall be designed with a minimum thickness (t) or dimension ratio (DR) in accordance with the above referenced AWWA Manual M23. The design pressure, unless noted otherwise, shall be the test pressure indicated in the pipe schedule in the Drawings.

D. Determination of External Loads: In lieu of the equations specified in the above referenced AWWA Manual M23, the dead (earth) loads shall be computed using the following 2 equations for trench or embankment loading as applicable:

1. Trench Condition:

$W_d = C_d w B_d^2$

Where: W_d = Earth Load in pounds per linear foot
C_d = Calculation Coefficient
Ku' = 0.13
W = 145 lb/ft^3
B_d = Trench width at top of pipe, feet

2. Positive Projecting Embankment Condition:

$W_c = C_c w B_c^2$

Where: W_c = Earth load in pounds per linear foot
C_c = Calculation coefficient (based on $r_{sd}P$ of 0.75)
Ku = 0.19
w = 145 lb/ft^3
B_c= Outside diameter of pipe, feet

E. Similarly, in lieu of the method specified in AWWA Manual M23, the truck live loads shall be determined using the method recommended by AASHTO - Standard Specifications for Highway Bridges. For depths of cover less than 10 feet HS-20 live loads shall be added to the earth loads to determine the total load. For depths of cover 3 feet or less, HS-20 live load plus impact shall be included.

F. Deflection Control: The deflection of the pipe after installation shall not exceed 0.03 times the outside diameter. If the calculated deflection exceeds 0.03 times the outside diameter the pipe class shall be increased or the quality of the pipe zone backfill shall be improved to achieve a higher modulus of soil reaction, E'. For purposes of calculation, values of E' shall be 1000 psi. The deflection lag factor shall be 1.25.

2.3 PIPE

A. The pipe shall be of the diameter and pressure class or DR specified or shown, shall be furnished complete with rubber gaskets, and all specials and fittings shall be provided as required in the Contract Documents. The dimensions and pressure classes for PVC pressure pipe shall conform to the requirements of AWWA C900 or C905 for cast iron pipe equivalent outside diameters.

B. Additives and Fillers: Unless otherwise provided in alternate qualification procedures of PPI-TR3, compounds which have a Hydrostatic Design Basis (HDB) of 4000 psi at 73.4 degrees F for water shall not contain additives and fillers that exceed the recommended values in Table 1, Part Y of PPI-TR3 (e.g., allowable content range for calcium carbonate is 0.0-5.0 parts per hundred of resin). If requested by the ENGINEER, the additive and filler content shall be determined using the pyrolysis method as specified in ASTM D 2584.

C. Joints: All joints for buried PVC pipe shall be either an integral bell manufactured on the pipe or a separate coupling, both employing a rubber ring joint. The bell and coupling shall be the same or greater thickness as the pipe barrel. The sealing ring groove in the coupling shall be of the same design as the groove in cast iron fittings and valves available from local water works supply distributors. Where shown or required, restrained joint pipe shall be ductile iron pipe cathodically protected in accordance with Section 13111 – Cathodic Protection. No restrained joint PVC pipe will be allowed.

2.4 FITTINGS

A. Fittings shall be ductile iron and shall conform to the requirements of AWWA C110, Class 250. PVC pipe fittings shall be mechanical joint.

B. All fittings shall be lined and coated in accordance with the requirements of Section 09900 – Painting and Coatings.

C. Each fitting shall be clearly labeled to identify its size and pressure class.

D. Ductile iron pipe fittings shall be cathodically protected in accordance with Section 13111 – Cathodic Protection.

2.5 COLOR

A. PVC pipe with the service designations RW and 3W shall be purple in color. The purple PVC pipe shall be colored with pigment at the time of extrusion by the manufacturer utilizing a method in conformance with AWWA C900. The remaining services shall be the standard manufactured color for PVC pipe and shall not be purple in color.

PART 3 EXECUTION

3.1 DELIVERY AND STORAGE

A. All pipe specified under this Section shall be handled according to the provisions of Section 02500 – Buried Pipe Installation.

B. Handling: Pipe, fittings and accessories shall be carefully inspected before and after installation and those found defective shall be rejected. Pipe and fittings shall be free from fins and burrs. Before being placed in position, pipe, fittings, and accessories shall be cleaned, and shall be maintained in a clean condition. Proper facilities shall be provided for lowering sections of pipe into trenches. Under no circumstances shall pipe, fittings or any other material be dropped or dumped into trenches.

C. Storage: Pipe should be stored, if possible, at the job site in unit packages provided by the manufacturer. Caution should be exercised to avoid compression damage or deformation to bell ends of the pipe. Pipe should be stored in such a way as to prevent sagging or bending and protected from exposure to direct sunlight by covering with an opaque material while permitting adequate air circulation above and around the pipe. Gaskets should be stored in a cool, dark place out of the direct rays of the run, preferably in original cartons.

3.2 INSTALLATION

A. All laying, jointing, and testing for defects leakage shall be performed in the presence of the ENGINEER and shall be subject to approval before acceptance. All material found during the process to have defects will be rejected and the CONTRACTOR shall promptly remove such defective materials from the site of the work.

B. Installation shall conform to the requirements of AWWA Manual M23, instructions furnished by the pipe manufacturer, and to the supplementary requirements specified herein. Wherever the provisions of this Section and the aforementioned requirements are in conflict, the more stringent provision shall apply.

C. Piping and its installation shall be In accordance with Section 02500 – Buried Pipe Installation and Section 15000 – Piping, General.

D. Short lengths of pipe shall be used in and out of each rigid joint or rigid structure. Piping that does not allow sufficient space for proper installation of jointing material shall be replaced by one of proper dimensions. Blocking or wedging between bells and spigots will not be permitted.

E. Joints shall be installed according to manufacturer's recommendations. Trenches shall be kept free of water until joints have been properly made. The maximum combined deflection at any coupling shall be in accordance with the manufacturer's recommendations.

F. Pipe shall be cut by means of saws, power driven abrasive wheels or pipe cutters that shall produce a square cut. No wedge-type roller cutters will be permitted. After cutting, the end of the pipe shall be beveled using a beveling tool, portable type sander or abrasive disc.

3.3 SERVICE CONNECTIONS

A. Service Connections: Direct tapping will not be permitted. Double strap stainless steel service clamps shall be used for all service connections. Service clamps shall have a bearing area of sufficient width along the axis of the pipe, so that the pipe will not be distorted when the saddle is made tight. An internal shell cutter shall be used to drill through the corporation stop to minimize PVC shavings, retain the coupon, and reduce stress. Single fluted shell cutters or twist drills are not acceptable. Lubricate the cutting and tapping edges of the tool with cutting lubricant. Make the cuts slowly and use the follower very lightly - do not force cutter through pipe wall. Shell cutter shall have sufficient throat depth to handle the heavy wall PVC pipe. Maximum outlet size permitted with service clamps or saddle is 2 inches.

B. Tapping sleeves and valves shall be used for all outlet sizes greater than 2 inches in diameter. Tapping sleeves shall be assembled and installed in accordance with the manufacturer's recommendations.

3.4 CORROSION CONTROL

A. Cathodic protection shall be provided for all metallic appurtenances (pipe restraints, fittings, saddles, etc.) in accordance with Section 13111 – Cathodic Protection and the Drawings.

3.5 TESTING

A. Mandrel Test: In addition to the requirements of Section 02640 Pipeline Testing and Disinfection, a mandrel test shall be performed on PVC pressure pipe smaller than 30-inches in diameter after backfilling and compacting but prior to final paving and prior to leakage testing. A rigid mandrel with a circular cross section having a diameter of at least 97 percent of true average inside diameter shall be pulled through the pipe by hand. The minimum length of the circular portion of the mandrel shall be equal to the nominal diameter of the pipe. If the mandrel sticks in the pipe at any point the pipe shall be repaired and retested.

B. Deflection Test: In addition to the requirements of Section 02640 Pipeline Testing and Disinfection, pipe 30-inches in diameter and larger shall be checked for deflection after

backfilling and compacting but prior to final paving and prior to leakage testing. At every point within the pipe, the measured vertical inside diameter shall not be less than 97 percent of the average inside diameter.

END OF SECTION

SECTION 02620 – HYDRAULIC STRUCTURE TESTING

PART 1 GENERAL

1.1 THE REQUIREMENT

A. The Contractor shall perform all cleaning, flushing, and testing, of all hydraulic structures and appurtenant piping, including conveyance of test water from Owner-designated source to point of use, and including all disposal thereof, complete and acceptable, all in accordance with the requirements of the Contract Documents.

B. Proposed water retaining walls in existing Oxidation Ditch Nos. 1 and 2 and the Chlorine Contact Tank shall also be hydraulically tested in accordance with the requirements specified herein.

1.2 REFERENCE SPECIFICATIONS, CODES, AND STANDARDS

A. Codes: All codes, as referenced herein, are specified in Section 01090 – References.

1.3 CONTRACTOR SUBMITTALS

A. A testing schedule, including proposed plans for water conveyance, control, and disposal shall be submitted in writing for approval in accordance with the provisions of Section 01340 – Shop Drawings, Product Data and Samples. Also, the Contractor shall submit written notice a minimum of 72 hours before testing is to start.

PART 2 PRODUCTS

2.1 MATERIALS REQUIREMENTS

A. Temporary valves, bulkheads, or other water control equipment and materials shall be as determined by the Contractor subject to the Engineer's review. No materials shall be used which would be injurious to the construction or its future function.

PART 3 EXECUTION

3.1 GENERAL

A. Water for testing will be furnished by the Owner as specified in Section 01510 – Temporary Utilities; however, the Contractor shall make all necessary provisions for conveying the water from the Owner-designated source to the points of use.

B. The Contractor shall be responsible for performing all work required by regulatory agencies, including, but not limited to, testing of the hydrostatic test water and obtaining all required permits for discharge of test water. The Contractor is notified that use of potable water for hydrostatic tests does not necessarily guarantee approval by regulatory agencies for discharge of hydrostatic test water into sanitary sewers or storm drains.

C. All testing operations shall be performed in the presence of the Engineer.

D. If industrial paint finishes or other protective coatings are to be applied to the interior surfaces of the hydraulic structure, such coatings shall be applied after all testing operations have been completed.

E. Release of water from structures, after testing has been completed, shall be in accordance with the testing plan submitted to and accepted by the Engineer and shall comply with all applicable laws and regulations.

3.2 PRELIMINARY CLEANING, FLUSHING, AND INSPECTION

A. Prior to testing, all hydraulic structures shall be cleaned by thoroughly hosing down all surfaces with a high pressure hose and nozzle of sufficient size to deliver a minimum flow of 50 gpm. All water, dirt, and foreign material accumulated in this cleaning operation shall be discharged from the structure or otherwise removed.

B. Standing water in or outside of the structure that would interfere with the observation of the exposed concrete surfaces of the tank shall be removed. The concrete surfaces and concrete joints shall be thoroughly inspected for potential leakage points. Areas of potential leakage shall be repaired prior to filling the structure with water.

C. All openings, fittings, and pipe penetrations in the structure's shell shall be inspected at both faces of the concrete, if practical. Defective or cracked concrete shall be repaired.

D. Interior liners, if present, shall be inspected for pinholes, tears and partially fused splices. Deficiencies shall be repaired.

3.3 TESTING OF HYDRAULIC STRUCTURES - PREPARATION

A. General: Testing shall be performed prior to backfilling, except where otherwise acceptable to the Engineer. Testing shall not be performed sooner than 14 days after all portions of structure walls and associated roof systems have been completed.

B. All structure penetrations and outlets shall be securely sealed to prevent the loss of water from the structure during the test. If the structure is to be filled using the inlet pipe, positive means shall be provided to check that water is not entering or leaving the structure through this pipe once the structure is filled to test level.

C. Penetrations and pipe, channel, and conduit outlets shall be monitored before and during the test to determine the watertightness of theses appurtenances. Leakage at these outlets shall be repaired prior to test measurements. No allowance shall be made in test measurements for uncorrected known points of leakage. Flow from an underdrain system, if present, shall be monitored during this same period and any increase in flow shall be recorded.

D. The initial filling rate shall not exceed a rate of 4ft/hour. Filling shall be continued until the water surface is at the design maximum liquid level or 4-inches below any fixed overflow level, whichever is lower.

E. The water shall be kept at the test level of unlined concrete tanks for at least three days prior to the actual test.

F. The exterior surfaces of the structure shall be inspected during the period of filling the tank. If any flow of water is observed from the structure's exterior surfaces, including joints or cracks, the defects causing the leakage shall be repaired.

3.4 TESTING OF HYDRAULIC STRUCTURES – MEASUREMENT

A. The test measurements shall not be scheduled for a period when the forecast is for a substantial change in the weather pattern.

B. The vertical distance to the water surface shall be measured from a fixed point on the structure above the water surface. Measurements shall be recorded at 24-hour intervals.

C. The test period shall be at least the theoretical time required to lower the water surface 3/8-inch assuming a loss of water at the maximum allowable rate. The test period need not be longer than five days.

D. The water temperature shall be recorded at a depth 18-inches below the water surface.

E. In uncovered structures, evaporation and precipitation shall be measured. Evaporation shall also be measured in well-ventilated covered structures.

F. The structure shall be inspected daily for damp spots, seepage, and leakage.

G. At the end of the test period, the water surface shall be recorded at the location of the original measurements. The water temperature and the evaporation and precipitation measurements shall be recorded.

H. The change in water volume in the structure shall be calculated and corrected, if necessary, for evaporation, precipitation, and temperature. If the loss exceeds the required criterion, the structure shall be considered to have failed the test. The structure shall also be considered to have failed the test if water is observed flowing or seeping from the structure if moisture can be transferred from the exterior surface to a dry hand.

3.5 QUANTITATIVE CRITERIA

A. Fully Lined Structures (HST-NML) – There shall be no measurable loss of water for the structure. No measurable loss of water means the drop in the water surface shall not exceed 1/8-inch in three days.

B. All Other Structures (HST-050) – The allowable loss for all other hydraulic structures, unless otherwise noted, shall not exceed 0.050% of the test water volume in 24-hours. The test shall be continued for a duration sufficient to cause a 3/8-inch drop in water surface assuming the loss of water is at the maximum rate, but not less than three days.

C. A restart of the test shall be required when test measurements become unreliable, in the opinion of the Engineer, or other external factors.

D. The Contractor shall be permitted to immediately retest a structure failing the test when no visible leakage is exhibited. If the structure fails the second test or if the Contractor does not exercise the option of immediately retesting after the first test failure, the interior of the structure shall be inspected by a diver or by other means to determine probable areas of leakage, at no additional cost to the Owner. The structure shall only be retested after the most probable areas of leakage are repaired.

E. Structures shall be retested until they meet the required criterion. Repairs shall be made to the probable leakage areas before each retest.

3.6 HYDRAULIC STRUCTURES – REPAIRS

A. Repairs to hydraulic structures shall conform to all the requirements of ACI Specification 503.7, "*Specification for Crack Repair by Epoxy Injection.*" Except as modified by these Contract Documents.

B. Crack repair epoxy adhesive shall be a two-component, solvent-free, moisture insensitive epoxy resin material suitable for crack grouting by injection of gravity feed. It shall be formulated for the specific size of opening or crack being injected.

C. Cracks on horizontal surfaces shall be repaired by gravity feeding crack repair epoxy adhesive into cracks per manufacturer's recommendations. If cracks are less than 1/16-inch in thickness they shall be pressure injected.

D. Cracks on vertical surfaces shall be repaired by pressure injecting crack repair epoxy adhesive through valves sealed to the surface with crack repair epoxy adhesive per manufacturer's recommendations.

3.7 CONNECTIONS TO EXISTING SYSTEM

A. Where connections are to be made to an existing potable water system, the interior surfaces of all pipe and fittings used in making the connections shall be swabbed or sprayed with a one percent hypochlorite solution before they are installed. Thorough flushing shall be started as soon as the connection is completed and shall be continued until all discolored water is eliminated.

3.8 TESTING OF APPURTENANT PIPING

A. Piping appurtenant to hydraulic structures shall be tested as specified in Section 02640 – Pipeline Testing and Disinfection.

END OF SECTION

SECTION 02640 – PIPELINE TESTING AND DISINFECTION

PART 1 GENERAL

1.1 THE REQUIREMENT

A. The Contractor shall perform all cleaning, flushing, and testing, of all pipelines, and disinfection of all pipelines for potable water, including conveyance of test water from Owner-designated source to point of use, and including all disposal thereof, complete and acceptable, all in accordance with the requirements of the Contract Documents.

B. Contractor shall conduct Closed Circuit Television (CCTV) inspections of all buried gravity sewer pipe 6-inches or larger in diameter after installation to verify the quality of work in accordance with the requirements of the specifications.

1.2 REFERENCE SPECIFICATIONS, CODES, AND STANDARDS

A. Codes: All codes, as referenced herein, are specified in Section 01090 – Reference Standards.

B. Commercial Standards:

ANSI/ASTM C 828	Low-Pressure Air Test of Vitrified Clay Pipe Lines
ANSI/AWWA B300	Hypochlorites
ANSI/AWWA B301	Liquid Chlorine
ANSI/AWWA C651	Disinfection of Water Mains

1.3 CONTRACTOR SUBMITTALS

A. A testing schedule, including proposed plans for water conveyance, control, disposal, and disinfection shall be submitted in writing for approval in accordance with the provisions of Section 01340 – Shop Drawings, Product Data and Samples. Also, the Contractor shall submit written notice a minimum of 72 hours before testing is to start.

B. The following items shall be submitted relative to the closed circuit television (CCTV) inspection of all new gravity sewer pipelines 6-inch or larger in diameter:

1. The Contractor shall provide the Engineer written notice a minimum of 24 hours before CCTV inspection is to start.

2. The Contractor shall provide post-installation digital videos and a suitable log for each gravity sewer line 6-inches or larger in diameter constructed as part of the Work. All CCTV inspection shall utilize DVDs or external hard drives for documentation, with each pipe reach recorded as an individual movie file (.mpeg, .mpg). Unedited recordings and an electronic PDF (.pdf) file of each inspection log shall be provided to the Engineer within 3 working days after the CCTV inspection.

PART 2 PRODUCTS

2.1 MATERIALS REQUIREMENTS

A. Temporary valves, bulkheads, or other water control equipment and materials shall be as determined by the Contractor subject to the Engineer's review. No materials shall be used which would be injurious to the construction or its future function.

B. Chlorine for disinfection shall be in the form of liquid chlorine, sodium hypochlorite solution, or calcium hypochlorite granules or tablets. Liquid chlorine shall be in accordance with the requirements of ANSI/AWWA B301; sodium hypochlorite and calcium hypochlorite shall be in accordance with the requirements of ANSI/AWWA B300. Liquid chlorine shall be used only (1) in combination with appropriate gas flow chlorinators and ejectors; (2) under the direct supervision of an experienced technician; and (3) when appropriate safety practices are observed.

C. Air test gages shall be laboratory-calibrated test gages and shall be recalibrated by a certified laboratory at the Contractor's expense prior to the leakage test, if required by the Engineer.

PART 3 EXECUTION

3.1 GENERAL

A. Water for testing will be furnished by the Owner as specified in Section 01510 – Temporary Utilities; however, the Contractor shall make all necessary provisions for conveying the water from the Owner-designated source to the points of use.

B. The Contractor shall be responsible for performing all work required by regulatory agencies, including, but not limited to, testing of the hydrostatic test water and obtaining all required permits for discharge of test water. The Contractor is notified that use of potable water for hydrostatic tests does not necessarily guarantee approval by regulatory agencies for discharge of hydrostatic test water into sanitary sewers or storm drains.

C. All testing operations shall be performed in the presence of the Engineer.

D. Conduct the tests on piping after the piping has been completely installed, including all backfill, supports, hangers, and anchors.

E. Pipelines conveying the following fluids shall be disinfected following hydraulic testing. All disinfection shall be done in the presence of the Engineer.

1. PW (potable water)

F. Disinfection operations shall be scheduled by the Contractor as late as possible during the contract time period so as to assure the maximum degree of sterility of the facilities at the time the Work is accepted by the Owner. Bacteriological testing shall be performed by a certified testing laboratory acceptable to the Owner. Results of the bacteriological testing shall be satisfactory to the State Department of Health or other appropriate regulatory agency.

G. Release of water from pipeline, after testing and disinfecting (as applicable) have been completed, shall be in accordance with the testing plan submitted to and accepted by the Engineer and shall comply with all applicable laws and regulations.

3.2 PRELIMINARY CLEANING AND FLUSHING

A. Prior to hydrostatic testing, all pipelines shall be flushed or blown out as appropriate.

3.3 CCTV INSPECTION OF SEWER PIPELINES

A. The Contractor shall perform CCTV inspection immediately after cleaning and backfill/compaction of all newly installed sewer pipelines to document the condition of the pipes, and to identify any defects requiring correction prior to acceptance.

B. All CCTV inspections shall be performed in the presence of the Engineer.

C. The Contractor shall inspect the lines using a 360 degree radial view color image camera. Camera position in the pipe during inspection shall be as close to the center point (vertically and horizontally) of the pipe as reasonably possible.

D. CCTV inspection shall be done on one sewer section at a time. CCTV inspection shall be performed prior to introduction of sewage flows through the pipe. The reaches shall be inspected from upstream to downstream, wherever possible. Should the camera get stuck in the sewer, the Contractor shall be responsible for all costs in extracting it and for then re-televising that portion of the pipeline. Costs related to difficulties encountered during CCTV inspection, and any repairs necessary to correct defects identified, are part of the Work and extra work claims will not be considered. Upon correction of defects (including backfilling and compaction) that portion of the pipeline shall again be televised to confirm that the repair was properly completed.

E. A log shall be submitted with each recording. The log shall identify the sewer line by manhole numbers, street location and plan sheet number. The log shall include the inspection date, location, distance, length, diameter, any connections, defects in the pipe installation and any repairs necessary. A sample form shall be required prior to any inspection for review and acceptance by the Engineer.

3.4 TESTING OF NON-PRESSURE PIPELINES

A. General: Unless otherwise specified, all process drains, storm drain lines and other miscellaneous drain piping shall be tested for exfiltration or infiltration, according to the City of Brentwood standards and as specified herein. Where the two specifications are in conflict, the more stringent of the two shall be followed. All manhole(s)/inlet(s) shall be tested for leakage, as specified. Manhole(s)/inlet(s) shall be tested prior to backfill placement, whereas all pipe shall be backfilled prior to testing. All leakage tests shall be completed and approved prior to placing permanent resurfacing. When leakage or infiltration exceeds the amount allowed by the Specifications, the Contractor, at its expense, shall locate the leaks and make the necessary repairs or replacements in accordance with the Specifications to reduce the leakage or infiltration to the specified limits. Any individually detectable leaks shall be repaired, regardless of the results of the tests.

B. Leakage Tests: Unless otherwise specified or shown, storm drainage and miscellaneous drainage systems, shall be tested for leakage as follows:

1. Pipe 24 inches or less in diameter, where difference in elevation between inverts of adjacent manhole(s)/inlet(s) is 10 feet or less; water exfiltration test or water infiltration test as approved. The Engineer may allow substitution of an air pressure test for the water exfiltration test.

2. Pipe 24 inches or less in diameter, where difference in elevation between inverts of adjacent manhole(s)/inlet(s) is greater than 10 feet; air pressure test or water infiltration test, or as approved.

3. Pipe greater than 24 inches in diameter; air pressure test or water infiltration test, or as approved.

C. Water Exfiltration Test: Each section of pipe shall be tested between successive manhole(s)/inlet(s) by closing the lower end of the pipeline to be tested and the inlet pipe of the upper manhole/inlet with stoppers. The pipe and manhole/inlet shall be filled with water to a point 4 feet above the centerline of the sewer at the center of the upper manhole/inlet; or if ground water is present, 4 feet above the average adjacent ground water level, whichever is higher.

The allowable leakage will be computed by the formula:

$E = 0.000012\ LD\ (H)^{1/2}$

Where:

E = Allowable leakage in gallons per minute of pipeline tested.

L = Length of pipeline tested, including laterals, in feet.

D = Internal diameter of the pipe in inches.

H = Difference in elevation between the water surface in the upper manhole/inlet and the centerline of the pipe at the lower manhole/inlet; or if ground water is present above the centerline of the pipe in the lower manhole/inlet, the difference in elevation between the water surface in the upper manhole/inlet and the ground water at the lower manhole/inlet.

D. Water Infiltration Test: If, in the opinion of the Engineer, excessive ground water is encountered in the construction of a section of the pipeline, the exfiltration test for leakage shall not be used. The end of the pipeline at the upper structure shall be closed sufficiently to prevent the entrance of water, and pumping of ground water shall be discontinued for at least 3 days, after which the section shall be tested for infiltration. The infiltration into each individual reach of pipeline between adjoining manhole(s)/ inlet(s) shall not exceed that allowed by the formula in Subsection 3.3C, where H is the difference in the elevation between the ground water surface and the invert of the sewer at the downstream manhole/inlet. Unless otherwise specified, infiltration will be measured by the Contractor using measuring devices approved by the Engineer.

E. Air Pressure Test: The Contractor shall furnish all materials, equipment and labor for making an air test. Air test equipment shall be approved by the Engineer. The Contractor may conduct an initial air test of the pipeline after densification of the backfill but, in the case of sanitary sewer testing, prior to installation of the building drains. Such tests will be considered to be for the Contractor's convenience and need not be

performed in the presence of the Engineer. Each section of pipeline shall be tested between successive manhole(s)/inlet(s) by plugging and bracing all openings in the main pipeline and the upper ends of all outlets and building drains. Prior to any air pressure testing, all pipe plugs shall be checked with a soap solution to detect any air leakage. If any leaks are found, the air pressure shall be released, the leaks eliminated, and the test procedure started over again.

1. The final leakage test of the pipeline and outlet branches shall be conducted in the presence of the Engineer and shall be performed in accordance with the procedures defined in ANSI/ASTM C828.

2. At the Contractor's option, joints may be air tested individually, joint by joint, with the use of specialized equipment. The Contractor shall submit its joint testing procedure for the Engineer's review and demonstrate, to the Engineer's satisfaction, that the testing procedure will adequately evaluate the pipe system being tested, prior to actual testing. Prior to each test, the pipe at the joint shall be wetted with water. The maximum test pressure shall be 3.0 psi. The minimum allowable pressure drop shall be 1.0 psi over a 30-second test period.

F. Water Pressure Test: Preparatory to testing, the section of the pipeline to be tested shall be filled with water and placed under a slight pressure for at least 48 hours. The pipeline shall then be brought up to the test pressure specified and maintained on the section under test for a period of not less than 4 hours.

1. Accurate means shall be provided for measuring the quantity of water required to maintain full pressure on the line for the test period, which volume shall not exceed:

$$L = \frac{CN\,D\,(P)^{1/2}}{1850}$$

Where:

L = Maximum allowable leakage in gallons per hour for the section of pipeline tested

N = Number of joints in length tested

D = Diameter of pipe in inches

P = Test pressure in psi

C = 1.0 for non-pressure polyethylene or PVC pipe

C = 3.0 for reinforced concrete pressure pipe with rubber joints, non-cylinder type

G. Deflection Test: All flexible and semi-rigid main line pipe shall be tested for deflection, joint displacement, or other obstruction by passing a rigid mandrel through the pipe by hand, not less than 30 days after completion of the trench backfill, but prior to permanent resurfacing. The mandrel shall be a full circle, solid cylinder, or a rigid, non-adjustable, odd-numbered leg (9 leg minimum) steel cylinder, approved by the Engineer as to design and manufacture. The circular cross section of the mandrel shall have a diameter of at least 95 percent of the specified average inside pipe diameter of the pipe and the minimum length of the circular portion of the mandrel shall

be equal to the nominal diameter of the pipe. Obstructions encountered by the mandrel shall be corrected by the Contractor.

3.5 TESTING OF MANHOLES AND INLETS

A. All manhole(s)/inlet(s) shall be hydrostatically tested for leakage after installation, but prior to being backfilled. Prior to hydrostatic testing, all manhole(s)/inlet(s) shall be visually inspected for leaks. All leaks or cracks shall be repaired by the Contractor, prior to hydrostatic testing, to the satisfaction of the Engineer.

B. All pipes entering the manhole/inlet shall be sealed at a point outside the manhole/inlet walls so as to include testing of the pipe/manhole joints.

C. The manhole/inlet shall be filled with water to a level 2 inches below the top of the frame. Safety lines shall be secured to all plugs utilized. After a period of at least one hour to allow the water level to stabilize, the manhole/inlet shall be refilled and the water level shall be checked. The water level shall again be checked after a period of 4 hours. If the water level is reduced by more than 1/4-inch, the leakage shall be considered excessive, and the Contractor shall be required to make all necessary repairs and retest the manhole/inlet. The exterior of the manhole/inlet shall be inspected during this period for visible evidence of leakage. Visible moisture, sweating, or beads of water on the exterior of the manhole/inlet shall not be considered leakage, but any water running across the surface will be considered leakage and shall be repaired to the satisfaction of the Engineer regardless of the volume of water lost.

3.6 TESTING OF PRESSURE PIPELINES

A. No section of the pipeline shall be tested until all field-placed concrete or mortar has attained an age of 14 days. The test shall be made by closing new valves when available, or by placing temporary bulkheads in the pipe and filling the line slowly with water. Testing shall not be performed against existing system closed valves. The Contractor shall be responsible for ascertaining that all test bulkheads are suitably restrained to resist the thrust of the test pressure without damage to, or movement of, the adjacent pipe. Any unharnessed sleeve-type couplings, expansion joints, or other sliding joints shall be restrained or suitably anchored prior to the test, to avoid movement and damage to piping and equipment. The Contractor shall provide sufficient temporary air tappings in the pipelines to allow for evacuation of all entrapped air in each pipe segment to be tested. After completion of the tests, such taps shall be permanently plugged. Care shall be taken to see that all air vents are open during filling.

B. Where any section of pipe is provided with concrete thrust blocking, do not make the pressure test until at least 5 days have elapsed after the thrust blocking is installed. If high-early cement is used for thrust blocking, the time may be reduced to 3 days. When testing PVC or HDPE piping, slowly fill the section of pipe to be tested with water and allow to stand for 24 hours under slight pressure to allow the PVC or HDPE pipe to accommodate swelling/absorption. Refill with makeup water before test.

C. Hydrostatic testing. Expel all air from the piping system prior to testing and apply and maintain the test pressure hereinafter specified by means of a hydraulic force pump. Valve off the piping system when the test pressure is reached and conduct the pressure test for the specified time, reopening the isolation valve only as necessary to restore the test pressure. The pump suction shall be in a barrel or similar device, or metered so that the amount of water required to maintain the test pressure may be

measured accurately. Pressure tests shall be made by filling the system for two hours continuously.

D. The pipeline shall be filled at a rate which will not cause any surges or exceed the rate at which the air can be released through the air valves at a reasonable velocity and all the air within the pipeline shall be properly purged. After the pipeline or section thereof has been filled, it shall be allowed to stand under a slight pressure for at least 24 hours to allow the concrete or mortar lining, as applicable, to absorb what water it will, to allow the pipe and water to achieve temperature equilibrium and to allow the escape of air from any air pockets. During this period, bulkheads, valves, and connections shall be examined for leaks. If leaks are found, corrective measures satisfactory to the Engineer shall be taken.

1. Repairs of defects that are discovered as a result of inspection or tests shall be made with new materials. Caulking of screwed joints, cracks, or holes will not be accepted. Tests shall be repeated after defects have been eliminated at no additional cost to the Owner.

E. The pipeline being tested will be equipped with a relief valve to permit pressure relief if the pressure exceeds 20 to 25 percent above the required test pressure to prevent pipeline failure.

F. Pressure Gauge(s): Provide sufficient number of calibrated pressure gauges capable of measuring pressure 50 percent over intended test pressure. Location of pressure gauges shall be determined by the Contractor and submitted with the pressure test plan, subject to approval by the Engineer.

G. Pressure gauges and relief valves shall be checked for accuracy to the satisfaction of the Engineer before being used during actual testing of pipeline.

H. The hydrostatic test shall consist of holding the test pressure on the pipeline for a period of 4 hours. The test pressure for distribution and transmission pipelines shall be 133 percent of the pipe pressure class shown or specified measured at the lowest point of the pipeline section being tested. The test pressure for yard piping shall be as shown or specified on the Piping Schedule measured at the lowest point of the pipeline section being tested. No pressure test will be required for a reservoir overflow line. All visible leaks shall be repaired in a manner acceptable to the Engineer.

I. Allowable Leakage:

1. If not specified in the piping schedule or in these Specifications, the maximum allowable leakage for distribution and transmission pipelines shall be 10 U.S. gallons per inch of diameter per mile of pipe per 24 hours for pipe with 40-ft or greater lengths between joints and with rubber-gasketed joints and 20 U.S. gallons per inch of diameter per mile of pipe per 24 hours for pipe with 20-ft or less lengths between joints and with rubber-gasketed joints.

2. Pipe with welded joints shall have no leakage.

3. Exposed Pipe: Leakage shall be zero at the test pressure hereinafter specified throughout the duration for exposed piping. Conduct testing and maintain the testing pressure for two hours continuously.

4. In the case of pipelines that fail to pass the prescribed leakage test, the Contractor shall determine the cause of the leakage, shall take corrective measures necessary to repair the leaks, and shall again test the pipelines.

J. The pipes shall be drained after hydrostatic testing, unless otherwise permitted by the Engineer.

K. Pneumatic Testing

1. General: Pneumatic testing shall be performed on pipes as indicated on the piping schedule. Air used for testing shall be dry and oil-free. The piping system, exclusive of possible localized instances at pump or valve packing, shall show no visual evidence of leakage.

2. Procedure: Apply preliminary pneumatic test pressure of 25 psig maximum to piping system prior to final leak testing, to locate visible leaks. Apply soap bubble mixture to joints and connection, examine for leakage. Correct visible leaks and repeat preliminary test until visible leaks are corrected. Gradually increase pressure in system to half of the test pressure. Test pressures are specified in the Pipe Schedule. Thereafter, increase pressure in steps of approximately one-tenth of specified test pressure until required test pressure is reached. Maintain pneumatic test pressure for minimum of 10 minutes and for such additional time as necessary to conduct soap bubble examination for leakage. Correct visible leakage and retest as specified.

3.7 TEST RECORDS

A. Records shall be maintained of all tests performed.

1. Test records shall include as a minimum:

2. Date and time of beginning and end of pipeline testing.

3. Identification of pipeline being tested.

4. Test fluid.

5. Test pressure.

6. Ambient temperature.

7. Pressure gauge reading taken during the test.

8. Quantities of make-up water added during the test.

9. Signatures of test technician, Contractor’s representative who witnessed the test, and the Owner representative who witnessed the test.

3.8 DISINFECTION OF PIPELINES

A. General: All potable water pipelines except those appurtenant to hydraulic structures shall be disinfected in accordance with the requirements of ANSI/AWWA C651 using the Continuous-Feed Method as modified herein.

B. Chlorination: A chlorine-water mixture shall be uniformly introduced into the pipeline by means of a solution-feed chlorinating device. The chlorine solution shall be introduced at one end of the pipeline through a tap in such a manner that as the pipeline is filled with water, the dosage applied to the water entering the pipe shall be approximately 50 mg/l. Care shall be taken to prevent the strong chlorine solution in the line being disinfected from flowing back into the line supplying the water.

C. Retention Period: Chlorinated water shall be retained in the pipeline long enough to destroy all non-spore-forming bacteria. This period shall be at least 24 hours. After the chlorine-treated water has been retained for the required time, the free chlorine residual at the pipeline extremities and at other representative points shall be at least 25 mg/l.

D. Chlorinating Valves: During the process of chlorinating the pipelines, all valves and other appurtenances shall be operated while the pipeline is filled with the heavily-chlorinated water.

E. Final Flushing: After the applicable retention period, the heavily chlorinated water shall be flushed from the pipeline until chlorine measurements show that the concentration in the water leaving the pipeline is no higher than that generally prevailing in the system or is acceptable for domestic use. If there is any question that the chlorinated discharge will cause damage to the environment, a reducing agent shall be applied to the water to neutralize thoroughly the chlorine residual remaining in the water.

F. Bacteriological Testing: After final flushing and before the pipeline is placed in service, a sample, or samples shall be collected from the end of the line, and shall be tested for bacteriological quality in accordance with the requirements of the State Department of Health or other appropriate regulatory agency. For this purpose the pipe shall be re-filled with fresh potable water and left for a period of 24 hours before any sample is collected. Should the initial disinfection treatment fail to produce satisfactory bacteriological test results, the disinfection procedure shall be repeated until acceptable results are obtained.

3.9 CONNECTIONS TO EXISTING SYSTEM

A. Where connections are to be made to an existing potable water system, the interior surfaces of all pipe and fittings used in making the connections shall be swabbed or sprayed with a one percent hypochlorite solution before they are installed. Thorough flushing shall be started as soon as the connection is completed and shall be continued until discolored water is eliminated.

3.10 FACTORY TESTING

A. Except where otherwise specified, all materials used in the manufacture of the pipe shall be tested in accordance with the applicable Specifications and Standards. Welds shall be tested as specified. The Contractor shall perform all tests at no additional cost to the Owner.

END OF SECTION

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SECTION 02700 – PRECAST TRENCH DRAINS

PART 1 GENERAL

1.1 THE REQUIREMENT

A. The Contractor shall furnish and install the precast polymer concrete trench drain, including all components and sub-components necessary to install the system as specified herein and in accordance with the requirements of the Contract Documents.

B. The requirements of Section 03400 – Precast Concrete Structures apply to this Section.

1.2 CONTRACTOR SUBMITTALS

A. Shop Drawings: Shop drawings and laying diagrams shall be completed by the manufacturer and submitted to the Engineer for approval in accordance with Section 01340 Shop Drawings, Product Data and Samples

B. Submit manufacturer's catalog data including: materials of construction, dimensions, spacing and construction of trench system, chemical resistance and installation guide.

C. Certifications: The Contractor shall furnish a certified affidavit of compliance to the Engineer guaranteeing that the products or materials furnished hereunder is in compliance with the requirements of these Specifications.

PART 2 PRODUCTS

2.1 GENERAL

A. The drain, grating and accessories in traffic areas shall be designed to withstand H-20 loading. Trench drains located in process areas where access is restricted to pedestrians shall be designed for a loading of 100 pounds per square foot. Presloped concrete drain components shall have a minimum average internal slope of 0.5%. Top of drain shall not be sloped. Drain and grating shall be installed flush with concrete surfaces. Drain shall have a capacity for a flow of 0.1 cfs minimum

2.2 TRENCH DRAIN CHANNELS

A. Trench drain channels shall be precast polymer concrete formed with a matched metal tooling utilizing a vinyl ester resin coating. Channels shall interlock fully and evenly with adjoining channels.

B. The interior surface of the grated line drain, below the level of the frame and grate and associated connections, shall be smooth. Grated line drain channel sections shall be manufactured of monolithic polymer concrete with no side extensions

C. Each channel shall have horizontal anchoring ribs located along the bottom of the channel as a means of mechanical engagement into the adjacent concrete.

D. The channel shall be supplied with a discharge outlet for a six inch drain line at the low point of the sloped trench, as shown on the Drawings.

2.3 CHANNEL GRATES

A. Channel grates shall bear evenly on the channel edges. Grates in traffic areas shall be able to withstand H-20 loading. Grates not in traffic areas shall be heavy duty non-traffic grates, able to withstand a minimum of 100 pounds per square foot. Lock down bolts and bars shall be provided and installed to hold the gratings firmly in place. All grates shall be made of a chemical resistant material or have a long wearing, manufacturer applied, chemical resistant coating. Grates shall fit into the channels without rocking.

B. Grated line drain frames and grates shall be manufactured of ductile iron conforming to the provisions in Section 05500 – Miscellaneous Metals. The frames and grates shall be hot dip galvanized. Bolts, nuts, frame anchors, and other connecting hardware shall conform to the provisions in Section 05500 – Miscellaneous Metals.

2.4 MANUFACTURERS

A. All components of the system shall be from a single manufacturer.

B. Manufacturer, or equal, shall be:

1. Quazite Polycast

2. ABT, Inc.

3. ACO Polymer Products, Inc.

PART 3 EXECUTION

3.1 DELIVERY AND STORAGE

A. Products specified under this Section shall be stored according to the manufacturer's recommendations.

B. All products found to be damaged prior to Substantial Completion shall be repaired or replaced by the Contractor.

3.2 INSTALLATION

A. The presloped drain system shall be installed in accordance with manufacturer's recommendations and approved shop drawings.

B. Excavation and backfill shall conform to the provisions in Section 02200 – Earthwork.

C. Excavation shall provide a minimum of 6" channel and bedding concrete on the sides and base of the trench drain.

D. Channel placement shall begin at the deepest end (tie in point).

E. Grated line drains shall be connected to new or existing drainage facilities as shown on the Drawings.

F. Channel ends are to be interlocked with surfaces reasonably flush and even. All joints shall be sealed according to manufacturer's recommendations and the Drawings. Joints are to be fully anchored using chair support. The channel shall be held in place during installation by an installation chair placed at the joint of each channel. The chairs shall allow alignment of channels, mechanically lock channels together, prevent floating during placement of concrete, and provide additional anchoring with the concrete slab.

G. The frame or grate of the grated line drain shall not extend above the level of the surrounding concrete work.

H. After adjoining concrete flat work has been placed and finished, all channels and grates shall be thoroughly cleaned and grates reinstalled and secured.

END OF SECTION

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SECTION 02810 – IRRIGATION

PART 1 GENERAL

1.1 DESCRIPTION

A. The work in this section consists of furnishing, layout and installing an irrigation system complete.

B. Related work specified elsewhere includes:

1. Section 02200, EARTHWORK

2. Section 02900, PLANTING

3. Section 16000, ELECTRICAL (stub-out for controllers).

1.2 QUALITY ASSURANCE

A. Manufacturer's Specifications: Follow manufacturer's current printed specifications and drawings in all cases where the manufacturers of articles used in the Contract furnish directions covering points not specified or shown in the drawings.

B. Ordinances and Regulations: All local, municipal and state laws, codes and regulations governing or relating to all portions of this work are hereby incorporated into and made a part of these Specifications. Anything contained in these Specifications shall not be construed to conflict with any of the above codes, regulations or requirements of the same. However, when these Specifications and Drawings call for or describe materials, workmanship or construction of a better quality, higher standard, or larger size than is required by the above codes and regulations, the provisions of these Specifications and Drawings shall take precedence. Furnish without extra charge additional materials and labor required to comply with above rules and regulations.

C. References, Codes and Standards:

1. State of California Model Water Efficient Landscape Ordinance

2. California Environmental Quality Act (CEQA)

3. Water Use Classification of Landscape Species (WUCOLS)

4. American Society of Irrigation Consultants (ASIC) Design Guidelines

5. California Landscape Standards, California Landscape Contractors Association, (CLCA) Sacramento, California

6. CAL-OSHA, title 8, Subchapter 4-Construction Safety Orders and Subchapter 7-General Industry Safety Orders

7. California Electric Code

8. California Plumbing Code (UPC) published by the Association of Western Plumbing Officials

9. NFPA 24, Section 10.4, Depth of Cover

10. Underwriters Laboratories (UL): Electrical wiring, controls, motors and devices, UL listed and so labeled

11. American Society of Testing Materials (ASTM)

D. Furnish without extra charge any additional material and labor when required by the compliance with all above mentioned codes and regulations, though the work be not mentioned in these specifications or shown on the drawings.

E. Reclaimed Water: Contractor to coordinate with owner and water purveyor to determine reclaimed water availability prior to the commencement of installing the irrigation system to coordinate inspection of the work and to verify all codes and regulations regarding use of reclaimed water. If reclaimed water is to be utilized, contractor to provide all pipe, equipment, signage and other warnings for reclaimed as required by local agency regulations.

F. Experience: Assign a full-time employee to the job as supervisor for the duration of the Contract with a certified landscape technician, irrigation certification through CLCA or minimum of four (4) years of experience in landscape irrigation installation.

G. Labor Force: Provide a landscape installation and maintenance force thoroughly familiar with, and trained in, the work to be accomplished to perform the task in a competent, efficient manner acceptable to the Engineer.

H. Explanation of Drawings:

1. Due to the scale of the Drawings, it is not possible to indicate all piping offsets, fittings, sleeves, etc., which may be required. Carefully investigate the conditions affected all of the work and plan accordingly, and furnish all required fittings. Install system in such a manner to avoid conflicts with planting, utilities and architectural features.

2. Do not install the irrigation system as shown on the Drawings when it is obvious in the field that obstructions, grade differences or discrepancies in arc dimensions exist that might not have been considered in engineering. Bring such obstruction or differences to the attention of the Engineer. Notify and coordinate irrigation Work with applicable contractors for location and installation of piping and sleeves through or under walls, pavement and structures. In the event this notification is not given, the Contractor shall assume full responsibility for any revision necessary.

I. Trench Interference with Tree Root Systems

1. Prior to trenching, layout main and lateral line locations within Drip Line of trees and review locations with Engineer. Relocate any lines that may interfere with existing root systems to avoid or reduce damage to root systems as accepted by Engineer.

2. Mechanical Trenching is not allowed within dripline of existing trees to be protected except as approved by Engineer

J. Coordinate plant locations with emitter locations.

1. Adjust plant locations in relation to the subsurface emitters as required to ensure that the plant roots receive the proper amount of water in order for it to thrive.

2. Coordinate planting and irrigation and provide hand watering of emitter irrigated as required to maintain moist root zones until end of plant establishment period.

1.3 PROTECTION OF EXISTING STRUCTURES AND UTILITIES

A. The Drawings show, if applicable, existing above and below grade structures and utilities that are known to the Owner. Locate known existing installations before proceeding with construction operations that may cause damage to such installations. Existing installations shall be kept in service where possible and damage to them shall be repaired with no adjustment of Contract Sum. Verify with Owner if As Built drawings are available.

B. If other structures or utilities are encountered, request Engineer to provide direction on how to proceed with the Work. If a structure or utility is damaged, take appropriate action to ensure the safety of persons and property.

C. Verify location of existing irrigation systems to be removed and/or replaced. Maintain any existing systems as required by the Drawings and Specifications, including temporary retention of systems necessary to maintain existing on site and adjacent planting.

1.4 SUBMITTALS

A. Materials List

1. Submit required copies of the cut sheets and a complete list of materials proposed for installation, along with any proposed substitutions clearly identified and obtain the Engineer's written approval thereof before proceeding. Use only accepted materials and items of equipment.

2. List all materials by manufacturer's name and model number.

B. Substitutions

1. If the Contractor desires to substitute a product, he shall list each item and note it as a "substitution" and provide the following information:

a. Descriptive information describing its similarities to the specified product.

2. If the product is approved and, in the opinion of the Engineer, the substituted product does not perform as well as the specified product, the Contractor shall replace it with the specified product at no additional cost to the Owner.

C. Operations and Maintenance Manuals

1. Prior to the final acceptance of the irrigation system, furnish three (3) individually bound Operation and Maintenance Manuals to the Engineer for use by the Owner. The manuals shall contain complete enlarged drawings, diagrams and spare parts lists of all equipment installed showing manufacturer's name and address. In addition, each Service Manual shall contain the following:

a. Index sheet indicating the Contractor's name, address and phone number.
b. Copies of equipment warranties and certificates.
c. List of equipment with names, addresses and telephone numbers of all local manufacturer representatives.
d. Complete operating and maintenance instructions in sufficient detail to permit operating personnel to understand, operate and maintain all equipment.
e. Parts list of all equipment such as controllers, valves, solenoids and heads.

D. Record Drawings

1. Dimension the location of the following items from two (2) permanent points of reference such as building corners, sidewalks, road intersections, etc:

a. Connection to existing water lines/meter
b. Connection to electrical power
c. Gate valves
d. Routing of irrigation pressure lines (a dimension at least every 100 feet and as required to identify all changes in direction and location)
e. Remote control valves
f. Routing of control valves
g. All sleeve locations
h. Routing of all control wiring
i. Include all invert elevations below 12"

2. Deliver a reproducible record drawing to the Engineer within seven (7) working days before the date of final review. Delivery of the record drawings shall not relieve the Contractor of the responsibility of furnishing required information in the future.

E. Controller Plan

1. Provide one Irrigation Diagram plan in each controller housing. The plan shall show the area controlled by each valve in different colors and for orientation, any major permanent structure such as buildings and roads.

2. Charts to be waterproof and hermetically sealed between two pieces of transparent 10 mil thick plastic and installed in each controller on the door as accepted by the Engineer no later than the time of the coverage test of the irrigation system.

F. Maintenance Material - supply the following tools to the Owner

1. Three (3) sets of specialized tools required for removing, disassembling and adjusting each type of head, valve or other equipment supplied on this project.

2. Two (2) keys for each type of equipment enclosure.

3. Two (2) keys for each type of automatic controller.

4. Two (2) keys for each type of valve (including square type key for valves larger than 2”)

5. All lock keys shall be keyed alike.

1.5 PRODUCT DELIVERY, STORAGE AND HANDLING

A. Furnish and deliver materials in manufacturer's packaging, bearing original legible labeling.

B. The Contractor is cautioned to exercise care in handling, loading, unloading, and storing PVC pipe and fittings. All PVC pipe shall be transported in a vehicle which allows the length of the pipe to lie flat so as not to subject it to undue bending or concentrated external load at any point. Any section of pipe that has been dented, cracked, or otherwise damaged shall be discarded and, if installed, shall be replaced with new piping.

1.6 SEQUENCING AND SCHEDULING

A. Acceptance: Do not install main line trenching prior to acceptance by Engineer of rough grades completed under another Section.

B. Coordination: Coordinate with the work of other sections to insure the following sequence of events:

1. Sleeves and Conduits: Installation of all sleeves and conduits to be located under paving and through walls prior to placement of those materials.

2. Bubbler Heads: Install after placement of tree, but prior to backfill with planter soil mix.

3. Coordinate work schedule with Owner to avoid disruption of landscape maintenance of existing landscaping.

4. Install piping prior to soil preparation (planting soil amendment installation).

1.7 WARRANTY, PER SECTION 01740.

A. In addition to manufacturer's guarantees and warranties, work shall be warranted for one (1) year from date of final acceptance against defects in material, equipment and workmanship. Warranty shall also cover repair of damage to any part of the premises resulting from leaks or other defects in materials, equipment and workmanship to the satisfaction of the Owner.

B. Include a copy of the warranty form in the Operation and Maintenance Manual.

1.8 OPERATION

A. Routine: Inspect and adjust all spray heads and control valves including raising or lowering of spray head heights to accommodate plant growth and weather conditions.

B. Controller: Inspect regularly for power interruption and reset clock as required. Adjust station timing to accommodate changes in plant growth and weather conditions.

C. System Failure: Perform all repairs within one (1) operating period. Replacements to match removed products and materials in all respects. Report promptly all damage not resulting from Contractor's operations. Repair all damage caused by Contractor at no expense to Owner.

D. Climate Change: Set and program automatic controllers in response to seasonal requirements and requirements of newly planted materials.

PART 2 PRODUCTS

2.1 PIPE

A. Pressure Main Line Pipe and Fittings: All PVC fittings shall bear the manufacturer's trademark name, material designation, size, applicable I.P.S. schedule and NSF seal of approval.

B. All main line pipe shall be solvent welded and manufactured from purple-colored PVC material and shall be printed on two sides with the wording "CAUTION-RECLAIMED WATER" every 24 inches along pipe.

1. PVC Pressure Rated Pipe: ASTM D2241 NSF approved Type I, Grade I, solvent welded PVC with an appropriate standard dimension ratio (S.D.R.)

2. PVC Scheduled Pipe: ASTM D1785 NSF approved, Type I

3. Grade I, solvent welded PVC

4. PVC Solvent-weld Fittings: ASTM D2466 Schedule 40, 1-2, II-I NSF approved

5. Solvent Cement and Primer for PVC solvent-weld pipe and fittings: Type and installation methods prescribed by the manufacturer

6. Connections between Main Lines and RCVs: Schedule 80 PVC (threaded both ends) nipples and fittings unless required otherwise by local jurisdiction

7. Valves 2-inch and larger shall be flanged only

C. All lateral line pipe shall be solvent welded Schedule 40 manufactured from purple-colored PVC material and shall be printed on two sides with the wording "CAUTION-RECLAIMED WATER" every 24 inches along pipe.

2.2 CONDUITS & SLEEVES

A. Sleeving shall be Schedule 40 PVC pipe sleeves and a minimum of two times the aggregate diameter of all pipes contained within the sleeve. Provide vertical sweep for all electrical conduit on each side of hardscape and terminate ends at 12" minimum depth and 12" from hardscape surface.

2.3 CONTROLLERS(S):

A. Wall-mounted irrigation controller

B. Rainbird ESP-20-LX

C. Provide rain shut off device as manufactured by Control System manufacturer capable of shutting off all control valves. Locate in a location exposed to rain and hardwire to controller.

2.4 CONTROLLER GROUND

A. Provide each pedestal controller with its own ground rod. Separate the ground rods by a minimum of eight feet. The ground rod shall be an eight-foot long by 5/8" diameter U.L. approved copper clad rod or as recommended by controller manufacturer. Install no more than 6" of the ground rod above finish grade. Connect #8-gauge wire with a U.L. approved ground rod clamp to rod and back to ground screw at base of controller with appropriate connector. Make this wire as short as possible, avoiding any kinks or bending. Install within pedestal housing base unless otherwise noted.

B. Provide each irrigation controller with its own independent low voltage common ground wire.

2.5 CONTROLLER ENCLOSURES

A. Stainless steel, NEMA Type 3 rated, with back panel, padlocking hasp and padlock Rain Bird, Le Meur, "Strong Box" or approved equal. See Detail for pedestal construction.

2.6 ISOLATION VALVE

A. Valves 3 inches and smaller: 125 lb. WSP bronze gate valve with screw-in bonnet, non-rising stem and solid wedge disc, NIBCO T-113 K, or approved equal. Valves shall be line size.

B. Valves larger than 2”: shall have square nut stem and o-ring connections for key operation.

2.7 BOX FOR ISOLATION

A. 10" diameter black plastic, Ametek, Brooks, Christy, Rain Bird with bolt down black lid marked "irrigation," or accepted equal. Avoid locating valve in paved areas. Provide H/20 Loading concrete box with bolt-down concrete lid if valve is located in paved area. Obtain location approval by Engineer.

B. Isolation valves shall be equipped with purple covers. Box shall have purple color lid (unless noted otherwise), with marked “irrigation” and with bilingual non-potable warning and symbol

2.8 REMOTE CONTROL VALVE

A. As shown on Drawings and with the following minimum requirements

1. Remote control valves shall be those normally manufactured for irrigation systems and shall have a slow, consistent speed of closure through entire closing operation, including last portion. To ensure this, the effective diaphragm working area/valve seating opening ratio must be a minimum 3 to 1.

2. Shall be mechanically self-cleaning to help prevent diaphragm or solenoid port plugging. To ensure this, the flush rod should be tapered to vary the size of the port opening as the diaphragm raises and lowers, thus allowing trapped material to escape. Rod is to be finished with a serrated surface to help scrub trapped material out. Screens not acceptable.

3. Shall have removable valve seat so valve can be repaired without removal from irrigation line.

4. Shall have ability to operate manually without the use of wrenches or special keys.

5. Shall have one-piece solenoid that attaches directly to valve without shunts or clips that can be lost.

6. Shall have cross top handle to adjust maximum travel of diaphragm to allow "tuning" of valve and closure.

7. Remote control valve to contain non-potable purple cap.

2.9 BOX FOR REMOTE CONTROL VALVE

A. Rectangular black plastic valve box - Ametek, Carson, Christy, Rain Bird or accepted equal with non-hinged bolt down purple for non-potable water colored lid marked “irrigation” and with bilingual non-potable warning and symbol. Box body shall have knock outs. Do not saw cut body. The minimum size box is as shown on Drawings. Increase box size as required to fit. Valve box lids are to indicate the controller letter and station number of valve as accepted by Engineer. Also refer herein to required polyurethane tag at valve solenoid control wire under Control Wires. Locate the identification in center of the lid. Provide separate box for each valve. Provide H/20 Loading concrete boxes with bolt-down concrete lids for all valves that occur in paved areas.

2.10 CONTROL WIRES

A. Connections between automatic controllers and the solenoid-operated electric control valves shall be made with direct burial copper wire 14- AWG-UF 600 volt (minimum size). Pilot wires shall be a color other than white, and shall be a different color for each automatic controller with wires sharing a common trench. Common wires shall be white in color, with a different color stripe for each controller with wiring sharing the same common trench. No stripe is required if multiple controller wiring is not present.

B. Size of wire shall conform to the remote control valve manufacturer's specification for control wire sizes, but in no case shall the control wire be smaller than #14. Runs over 2,000 lineal feet shall be #12- AWG-UF 600-volt copper wire.

C. All wire splices are to be made within a valve box, with a copper crimp-type connector, and a "3-M" #DBY splice kit or Rain Bird “DBTWC25”.

D. Use continuous control wiring between controllers and remote control valves (no splices).

E. Provide polyurethane tag at valve solenoid control wire that shows the controller number and station number. Also refer to valve box lid identification.

F. Provide a spare control wire in each RCV box for future.

2.11 SPRAY HEADS

A. Pop-up as shown on drawings and with the following minimum requirements:

1. Shall have approximately 30 psi water pressure coming out of nozzle to prevent "fogging" or misting. Shall have pressure-compensating devices.

2. Shall have ability to prevent low head drainage. Use heads with integral check valves.

3. EXAMPLE – Rain Bird 1800 Spray Body with SAM -PRS Series

4. Shall not have spray blocked by turf or shrubbery; use minimum 4" pop-ups in turf areas.

5. Spray to contain purple non-potable cover/cap

2.12 ROTOR HEADS

A. As shown on drawings and with the following minimum requirements:

B. Heads shall have exact matched precipitation rates. Radius and precipitation rates must be the same.

C. EXAMPLE – Rain Bird 5000/5000 Plus Series with MPR, PRS and SAM

D. Rotor to contain purple non-potable cover/cap

2.13 SWING JOINTS

A. Heads and Bubblers: Use Dura, Lasco, Rain Bird or equal pre-assembled swing joints with O-rings.

2.14 TREE BUBBLERS

A. As shown on drawings

2.15 RCV IDENTIFICATION TAGS

A. Plastic or brass tags with valve number, approximately 2” by 2” with number imprinted, as accepted by Owner.

2.16 MISCELLANEOUS INSTALLATION MATERIALS

A. Solvent Cement and Primers for Solvent-weld Joints: Make and type approved by manufacturer(s) of pipe and fittings. Maintain cement proper consistency throughout use.

B. Pipe and Joint Compound: Permatex: Do not use on head inlet port.

2.17 MISCELLANEOUS EQUIPMENT/ACCESSORIES

A. Concrete for equipment pads (and thrust blocks if Bell-Type Pipe with O-Rings is required): Poured-in-place Class A concrete per Section 90 of the Caltrans Standard Specifications.

B. Sleeves and Conduits: See Drawings.

2.18 OTHER EQUIPMENT

A. As shown on Drawings and required for a fully functional irrigation system.

PART 3 EXECUTION

3.1 EXAMINATION

A. Sleeves and Conduits: Verify that all installed sleeving and conduits are undisturbed and are free of defects or errors introduced by the work of other sections.

B. Water Meter/Water Pressure: Test and verify that existing water pressure is the minimum pressure at maximum system g.p.m. to operate the irrigation system as indicated on the drawings.

C. Stub-outs: Verify that all stub-outs to be provided under another contract are correctly sized, located and installed as noted on Drawings.

D. Notification: Submit written notification to Engineer within ten (10) working days of above inspections describing all acceptable and non-acceptable site conditions.

3.2 CONNECTIONS TO SERVICES

A. Provide and coordinate connection to water meter.

B. Provide and coordinate connection of irrigation controller to electrical power source.

3.3 INSTALLATION

A. Install irrigation system components in accordance with this Section, with the Drawings, with the manufacturer’s recommendations, and with established industry standards. The Contractor shall do nothing that may jeopardize any manufacturer warranty.

B. Automatic Controller

1. General: Install with lock box cutoff switch per local code and manufacturer's current printed specifications. Provide each controller with its own independent low voltage common ground wire.

2. Connection to Valves: Connect remote control valves to controller in clockwise sequence to correspond with station setting beginning with Stations 1, 2, 3, etc.

3. Labeling: Affix controller letter (i.e., "A") on inside of controller cabinet door with minimum of one-inch (1") high permanent letter.

4. Irrigation Diagram: Affix a non-fading, waterproof copy of irrigation diagram to cabinet door below controller name. Irrigation diagram to be sealed between two plastic sheets, 20 mil. minimum thickness. Use a legible reduced copy of the Record Drawing for the irrigation diagram clearly showing all valves operated by the controller, station, number, valve size, and type of planting irrigated. Color code area operated by each valve.

C. Control Wiring

1. General: Install control wires in common trenches with irrigation mains and laterals wherever possible. Lay to the bottom side of pipe line. Provide looped slack at valves. Snake wires in trench to allow for contraction of wires. Tie wires in bundles at 10 ft. intervals.

2. Extra Length: Provide 30 inches (30") extra control wire at each remote control valve splice to facilitate the removal of the remote control bonnet to finish grade without cutting wires.

3. Spare: Install one unconnected spare control wire running from the controller through each intermediate control valve box.

4. Size: Minimum size of wire is to be determined strictly by the manufacturer's current printed specifications for remote control valves, but not smaller than #14.

5. Detection Wire: Install a bare #12 copper wire or greater on top of the PVC supply line for the purpose of possible future mine detection search. Install the control wires on the bottom of the PVC supply line with electrical tape every ten feet (10').

6. Splicing: Crimp control wire splices at remote control valves. Seal with specified splicing materials. In-line splices will be allowed only on runs exceeding 2500 feet and only in junction boxes.

D. Rain Shutoff Switch

1. Install switch in area not affected by irrigation or rain shadow. Provide wires in rigid conduit as accepted by Engineer.

E. Excavating and Trenching

1. Prior to trenching, layout main and lateral line locations within Drip Line of trees and review locations with Engineer. Relocate any lines that may interfere with existing root systems to avoid or reduce damage to root systems as accepted by Engineer.

2. Dig trenches wide enough to allow a minimum of three inches (3") between parallel pipe lines.

F. Conduits and Sleeves

1. Coordination: Provide conduits and sleeves and coordinate installation with other trades.

2. Extent: Install conduits and sleeves where control wires and pipes pass under paving or through walls as shown on Drawings. Extend twelve inches (12") beyond edges of paving and walls and cap ends until ready for use.

G. Pipeline Assembly

1. Install pipe and fittings in accordance with manufacturer's current printed Specifications.

2. Clean all pipes and fittings of dirt, scale and moisture before assembly.

3. Solvent-welded Joints for PVC Pipes

   a. Solvents: Use solvents and methods specified by pipe manufacturer.
   b. Curing Period: Minimum of one (1) hour before applying any external stress on the piping and at least 24 hours before placing the joint under water pressure.

4. Threaded Joints for Plastic Pipes

   a. Use Permatex on all threaded PVC fittings except irrigation heads and quick coupler valve ACME threads.
   b. Joining: Use strap-type friction wrench only. Do not use metal-jawed wrench. Assemble finger tight plus one or two turns.

5. Laying of Pipe

   a. Bedding On-grade: Remove from trench all rocks or clods. Bed pipe in at least 2 inches of soil excavated from trench. Backfill on all sides of piping to provide a uniform bearing.
   b. Snaking: Snake pipe from side to side of trench bottom to allow for expansion and contraction. Minimum allowance for snaking is one (1) additional foot per 100 ft. of pipe.
   c. Moisture Restrictions: Do not lay PVC pipe when there is water in the trench. Do not assemble PVC pipe unless the pipe is dry.

H. Closing of Pipe and Flushing of Lines

1. Capping: Cap or plug all openings as soon as lines have been installed to prevent entrance of materials that would obstruct the pipe. Leave in place until removal is necessary for completion of installation.

I. Detection Wire and Warning Tape

1. Install a bare # 12 copper wire or greater on top of the PVC supply line for the purpose of possible future mine detection search.

J. Control Valves

1. Install in valve boxes where shown on Drawings and group together where practical. Install box flush with finish grade, not necessarily level. If valve occurs in drainage swale, relocate out of drainage swale as approved by Engineer.

2. Where two or more valves are installed adjacent to each other, provide at least six inches (6") separation. Align boxes in a row, perpendicular with pavement edge.

3. Permanently mark valve box lid with 2" black valve number and controller letter or with numbered metal tag inside box as approved by Engineer.

4. Refer to control wiring for required spare wire in each valve box.

K. RCV Identification Tags

1. Install in remote control valve box as recommended by manufacturer and as accepted by Engineer.

L. Pop-up Spray Heads and Rotors

1. Place all irrigation heads in planting areas with top of heads set to finish grade or top of mulch as required.

2. Place part-circle pop-up irrigation heads two inches (2") from edge of and flush with top of adjacent walks, header boards, curbs and mowing bands or paved areas and 12 inches (12") from building foundations at time of installation.

3. Set all irrigation heads in turf to allow for settlement. Adjust as required after settlement. Hold heads two inches (2") clear of pavement edge.

M. Bubblers

1. Coordinate installation with planting contractor to insure timely and proper placement of heads at new planting.

3.4 MISCELLANEOUS EQUIPMENT

A. Install miscellaneous equipment with concrete footings, brackets, etc., as required and as recommended by manufacturer.

3.5 FIELD QUALITY CONTROL

A. Testing of Irrigation System

1. Make hydrostatic tests with risers capped when welded PVC joints have cured at least 24 hours. Center load piping with backfill to prevent pipe from moving under pressure. Keep all couplings and fittings exposed.

2. Install two (2) pressure gauges at opposite ends of main line system. Pump system up to a minimum of 125 psi the day preceding the scheduled test and verify that pressure is holding. Inspect system early following day and immediately notify Engineer if the test confirmation must be postponed.

3. Apply continuous static water pressure of 125 psi in accordance with Caltrans Standard Specifications Section 20-5.03H, except after a drop in pressure (5 psi maximum), then the pressure must stabilize and remain stable for a one (1) hour minimum period before acceptance of the test.

4. Leaks detected during tests shall be repaired and test repeated until system passes tests at no additional cost to Owner.

B. Adjustment of the System

1. Flush and adjust all irrigation heads for optimum performance and to prevent overspray onto walks, roadways and buildings. Adjust the arc and radius as applicable.

2. Include as a part of the work any nozzle changes or arc adjustments necessary due to daytime windy conditions during grass establishment period. After grass has been established and watering can be performed during calm early morning or evening hours, make any required adjustments to nozzles and arcs.

3. Set all irrigation heads perpendicular to finished grades unless otherwise noted on the drawings.

4. When the landscape irrigation system is completed and before planting, perform a coverage test in the presence of the Engineer to determine if the water coverage for planting areas is adequate.

5. Test controllers individually in the presence of the Engineer. Demonstrate that all control valves operate electronically. Provide vehicles and radio equipment as necessary to expedite this process.

6. Demonstrate to Engineer that irrigation scheduling programmed into controller is adequate for plant requirements without causing runoff, and that scheduling capacities of controller are utilized.

3.6 BACKFILL AND COMPACTING

A. General: After system is operating and required tests and reviews have been made, backfill excavations and trenches with clean soil, free of debris.

B. Backfill for All Trenches: Regardless of the type of pipe covered, compact to minimum 95% density under pavements and 85% under planted areas.

C. Finishing: Dress off areas to finish grades. Re-dress any areas which subsequently settle.

D. Owner's testing agency will test backfill compaction in areas under paving.

3.7 MAINTENANCE

A. The entire irrigation system shall be under full automatic operation for a period of 2 days prior to any planting.

B. The Engineer reserves the right to waive or shorten the operation period.

C. Maintain/repair system for full duration of plant maintenance period.

3.8 REVIEWS PRIOR TO ACCEPTANCE

A. Notify the Engineer in advance for the following reviews, according to the time indicated

1. Supply line pressure test and control wire installation - 72 hours

2. Coverage and controller test - 72 hours

3. Final review - 7 days

B. No reviews will commence without record drawings, without completing previously noted corrections, or without preparing the system for review.

3.9 FINAL REVIEW AND CLEANUP, PER SECTION 01710.

A. Operate each system in its entirety for the Engineer at time of final review. Any items deemed not acceptable by the Engineer shall be reworked to the complete satisfaction of the Engineer.

B. Provide evidence to the Engineer that the Owner has received all accessories and equipment as required before final review can occur.

C. Final acceptance and start of warranty period will occur no earlier than the end of the plant maintenance period.

D. For time of final review, Contractor shall arrange a meeting with the Owner's maintenance personnel to demonstrate the operation of the irrigation systems automatically in order to verify acceptance and to familiarize the maintenance personnel with the system and recommended programming.

END OF SECTION

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SECTION 02831 – FENCING

PART 1 GENERAL

1.1 THE REQUIREMENT

A. The Contractor shall furnish and install fencing and gates as shown and specified and all appurtenant work, complete, all in accordance with the requirements of the Contract Documents.

1.2 REFERENCE SPECIFICATIONS, CODES, AND STANDARDS

ASTM A36	Standard Specification for Carbon Structural Steel.
ASTM A53	Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc- Coated Welded and Seamless ASTM A500 Standard Specification for Cold-Formed Welded and Seamless Carbon Steel Structural Tubing in Rounds and Shapes.
ASTM A123	Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products
ASTM A307	Standard Specification for Carbon Steel Bolts and Studs, 60,000 PSI Tensile Strength
ASTM A513	Electric-Resistance-Welded Carbon and Alloy Steel Mechanical Tubing
ANSI/AWS D1.1	Structural Welding Code – Steel.

1.3 CONTRACTOR SUBMITTALS

A. Shop drawings and design calculations of gates, typical fence and fence corner construction shall be submitted prior to fabrication and construction according to the provisions of Section 01340 – Shop Drawings, Product Data and Samples.

B. Manufacturer's brochure with complete description of products.

PART 2 PRODUCTS

2.1 GENERAL

A. Fencing shall be 6 feet high unless otherwise shown. All fencing materials shall be galvanized steel. All materials and components shall be new, first quality items specifically manufactured for the intended application.

2.2 FENCING

A. Fence shall be fabricated as steel member as shown on the drawings.

B. Nuts, bolts and screws shall be of steel, hot-dipped galvanized after fabrication, minimum size 3/8-inch diameter.

C. Manufacturers or equal:

1. Builders Fence Company Inc
2. A-1 Fence Company

3. California Fence and Supply
4. Fence Factory

PART 3 EXECUTION

3.1 PRODUCT DELIVERY, STORAGE AND HANDLING

A. Delivery of Materials: Manufactured materials shall be delivered in containers or packages approved by the manufacturer. Fence products shall have tags bearing the names of the manufacturer and item.

B. Storage: Products shall be carefully stored above ground in a manner acceptable to the manufacturer, in an area that is protected from all deleterious elements. Storage conditions shall prevent damage to the product or marring of finishes.

3.2 INSTALLATION

A. All obstructions which interfere with the proper alignment of construction of fences shall be removed and disposed of at the expense of the Contractor.

B. Line posts shall be spaced at not more than 10-foot intervals, measured from center to center of the posts and generally parallel to the ground slope. Posts shall be set plumb.

C. Bracing shall be provided at all end, gate, and corner posts, the latter in both directions. Horizontal brace rails shall be set midway between top rail and ground running from the corner, end, or gate post to first line post. Diagonal tension members shall connect tautly between posts below horizontal braces.

D. Any galvanized coating damaged during construction of the fencing shall be repaired by application of molten Galvo-Weld; Galvinox; or equal.

E. Discrepancies between the shop drawings and field conditions shall be brought to the attention of the ENGINEER immediately upon discovery.

F. Manufacturer’s representative shall be on-site for installation, testing and training in accordance with these specifications.

G. The installation of all items under this specification shall conform to applicable codes and manufacturer's published or written installation instructions.

H. Fences, and posts shall be plumb and level.

I. All field welds and any abrasions to factory coatings shall be thoroughly cleaned, re-primed, and touched-up with the approved coating system.

END OF SECTION

SECTION 02900 – PLANTING

PART 1 GENERAL

1.1 DESCRIPTION

A. Provide planting work and planting maintenance complete as shown on the drawings and as specified including staking and layout of the landscaping, including soil sampling.

B. Related work specified elsewhere includes

1. Section 02050, DEMOLITION & RECONSTRUCTION
2. Section 02100, SITE PREPARATION
3. Section 02200, EARTHWORK
4. Section 02810, IRRIGATION

1.2 QUALITY ASSURANCE

A. Reference Standards

1. All local, municipal and state laws, codes and regulations relating to all portions of this work are to be incorporated as part of these Specifications. These specifications shall not be construed to conflict with any of the above codes, regulations or requirements. The Specifications and Drawings shall take precedence when they call for materials, workmanship or construction of a better quality or higher standard than required by the above mentioned codes and regulations. Furnish without extra charge additional materials and labor required to comply with above rules and regulations.
2. State of California Model Water Ordinance
3. Public utility agency having jurisdiction over the project work.
4. "Sunset Western Garden Book," Lane Publishing Co., Menlo Park, California; current edition.
5. "American Standards for Nursery Stock," American Association of Nurseryman, 230 Southern Building, Washington, D.C. 20005.
6. International Society of Arboriculture, Guide for Plant Appraisal, latest version.
7. US Composting Council Compost Analysis Program (CAP)
8. US Composting Council (USCC) Seal of Testing Assurance (STA) program.
9. Test Methods for the Evaluation of Composting and Compost (TMECC)
10. Manufacturer's recommendations.

B. Qualifications

1. Experience: Assign a full-time employee to the job as foreman for the duration of the Contract who is certified landscape technician, certification through CLCA or minimum of four (4) years of experience in landscape installation and maintenance supervision, with experience or training in turf management, entomology, pest control, soils, fertilizers and plant identification

2. Labor Force: Provide a landscape installation and maintenance force thoroughly familiar with, and trained in, the work necessary to complete the tasks described herein in a competent, efficient manner acceptable to the Owner.

C. Requirement

1. Site Visit: At beginning of work, visit and walk the site with the Engineer to clarify scope of work and understand existing project/site conditions.

2. Supervision: The foreman shall directly supervise the work force at all times and be present during the entire installation. Notify Engineer of all changes in supervision.

3. Identification: Provide proper identification at all times for landscape maintenance firm's vehicles and a labor force uniformly dressed in a manner satisfactory to Engineer.

4. Protect all existing and new plants from construction activities, deer & rodents: Contractor shall be responsible for protection of all planting per Part 3.

D. Plant Material Standards

1. Quality and Size of Plants: Conform to the State of California Grading Code of Nursery Stock, No. 1 grade. Use only nursery-grown stock which is free from insect pests and diseases.

2. Comply with federal and state laws requiring inspection for plant diseases and infestations. Submit inspection certificates required by law with each shipment of plants, and deliver certificates to the Owner. Obtain clearance from the County Agricultural Commissioner as required by law, before planting plants delivered from outside the County in which planted.

E. Soils & Amendment Testing

1. All soils & amendments to be tested for agricultural suitability by one of the following accredited soil testing laboratory (or approved equal). Components of the test shall include all major nutrients, pH, salinity, boron, sodium, micronutrients, copper, zinc, manganese and iron, adsorption rate, organic content and texture. The laboratory report shall include recommendations for adjusting fertilizer and amendment quantities.

   Soil and Plant Laboratory, Inc.
   352 Matthew Street (P.O. Box 153), Santa Clara, CA 95052; (408-727-0330)
   Wallace Laboratories, LLC
   365 Coral Circle, El Segundo, CA 02345, (310-615-0016)

Root Zone Associates
P.O. Box 18911, San Jose, CA 95118; (408-264-7024)

2. Upon approval of the laboratory's report by the Engineer, the recommendations in the report shall become a part of the Specifications and the soil preparation procedures, quantities of soil amendment, fertilizer and other additives shall be adjusted to conform with the report at no additional cost to the owner. Note that there is a minimum quantity of organic amendment specified elsewhere in this specification section.

3. Significant issues with soil quality will require soil to be retested in the locations identified on Soil Analysis Plan, prior to proceeding with plant installation, to ensure that the recommendations in the report have been followed and the In-Situ Topsoil is agriculturally suitable as described in Part 2.

1.3 DEFINITIONS

A. Subsoil: Soil beneath the level of subgrade; soil beneath the topsoil layers of a naturally occurring soil profile, typified by less than 1 percent organic matter and few soil organisms. Subsoil is defined as either existing site soil located below the topsoil prior to construction activities, or select fill used for rough grading during construction. Subsoil cannot be considered for use as planting soil.

B. Surface Soil: Soil that is present at the top layer of the existing soil profile. In undisturbed areas, surface soil is typically called "topsoil," but in disturbed areas such as urban environments, the surface soil can be subsoil.

C. Topsoil: Top layer of the soil profile consisting of existing native surface topsoil or existing in-place surface soil; the zone where plant roots grow. Its appearance is generally friable, pervious, and black or a darker shade of brown, gray, or red than underlying subsoil; reasonably free of subsoil, clay lumps, gravel, and other objects larger than 2 inches (50 mm) in diameter; and free of weeds, roots, toxic materials, or other non-soil materials.

D. Planting Soil: Approved existing topsoil or imported planting soil, meeting the requirements herein. Subsoil cannot be considered for use as planting soil.

1.4 SUBMITTALS

A. The following shall be submitted to the Engineer for approval prior to the installation of landscape materials and products.

B. Manufacturer’s Technical data sheets for fertilizers, turf, and all other products and materials listed herein.

C. Manufacturer’s technical data sheets for amendments. Reports to be dated no more than 3 months prior to soil preparation.

D. 1-pint samples of imported soils, organic amendments/compost, mulches, and stones.

E. Submit planting soil and organic amendment laboratory reports a minimum of 3 weeks prior to beginning soil prep. See below for required soil analysis reports.

F. Required Soil Analysis Reports. Reports to be dated no more than 3 months prior to soil preparation.

1. Soil Analysis Plan: Contractor to submit annotated plan showing confirmed locations of all required soil tests. Each location is to be identified with a unique label.

2. Existing Planting Soil Analysis: After approval of the Soil Analysis Plan, rough grading, and topsoil placement, contractor to obtain 3 representative samples of in situ topsoil taken from approved site locations at depth of 4" to 6" below finish grade and submit to an accredited soils testing laboratory for "agricultural suitability" analysis, including particle size, infiltration rate, and evaluation of physical and chemical properties of soil and recommendations for adding amendments and fertilizers to the soil.

3. Amended Planting Soil Analysis: Significant issues with soil quality will require soil to be retested in the locations identified on Soil Analysis Plan, prior to proceeding with plant installation, to ensure that the recommendations in the report have been followed and the final Planting Soil is agriculturally suitable as described in Part 2.

G. The Contractor is responsible to follow all local water ordinances and make available to the local agency the soil analysis report and verification of its implementation as required.

H. Delivery Receipts upon request by Owner, provide delivery receipts for quantities of soil & amendments delivered to the site.

I. Plant sample of each variety of plant. Samples to be delivered to the site 2 weeks prior to plant installation and stored and maintained separately from entire quantity of delivered plants. Contractor to maintain plants throughout maintenance period. Plants to be reviewed in a single site visit.

J. Representative photos of each plant species. Photos to be of plants to be delivered to site and not a stock photograph.

K. Entire plant quantity delivered to the site. Plants to be reviewed prior to installation during a single site visit.

L. Representative photos of each tree species (unless trees previously tagged at nursery by Engineer). Photos to be of trees to be delivered to site and not a stock photograph.

1.5 WARRANTY AND REPLACEMENT

A. Maintenance Period: See Part 3.

B. Warrant the work against weed growth for a period of four (4) months after application of Pre-Emergence Weed Killer.

C. Warrant all plants to be in a healthy, thriving condition until the end of the maintenance period, and deciduous trees beyond that time until active growth is evident.

D. Replace all dead and damaged plants and plants not in a vigorous condition immediately upon discovery and as directed by the Engineer and at no cost to the owner. Install replacement plants before the final acceptance of the maintenance period in the size specified.

E. Warrant all products, prepared soils and plant material installed and maintained by contractor against defects for a period of one year after final acceptance of the maintenance period.

PART 2 PRODUCTS

2.1 EXISTING PLANTING SOIL (ON-GRADE)

A. Existing Planting Soil is defined as on-site topsoil that is either to be removed and stockpiled for reuse or to remain in place during construction. Satisfactory planting soil shall be free of subsoil, clay, lumps, stones, and other objects over 4" in diameter, and without weeds, roots, and other objectionable material. The soil shall be fertile, friable, natural, productive soil containing a normal amount of humus, and shall be capable of sustaining healthy plant life. Soil shall not be infested with nematodes or with other noxious animal life or toxic substances. Soil shall be obtained from well-drained, arable land, and shall be of an even texture. Soil shall not be taken from areas on which are growing any noxious weeds such as Morning Glory, Equisetum, or Bermuda Grass, etc.

B. If herbicide contamination is suspected then a radish/ryegrass growth trial must be performed. Consult with Engineer prior to decision to test or not.

C. Amended Planting Soils are to conform with the following target levels. Elements are expressed as mg/kg dry soil or mg/l for saturation extract

pH value 6.5-7.9, lime none present salinity (ECe) 0.5-3 milli-mho/cm chloride <150 ppm nitrate 20-30 ppm SAR <3 phosphorus 8-20 mg/kg potassium 60-180 mg/kg	iron 4-15 mg/kg manganese0.6-3.0 mg/kg zinc 1-3 mg/kg copper 0.2-3.0 mg/kg boron0.2-0.5 mg/kg magnesium 25-100 mg/kg sodium <200 mg/kg sulfur 25-100 mg/kg

2.2 ORGANIC AMENDMENT FOR PLANTING SOILS (ON-GRADE)

A. Ground Redwood or Ground Fir Bark with the following properties:

Percent Passing	Sieve Designation		
100	9.51 mm	3/8"	
50-60	6.35 mm	1/4"	
20-40	4.76 mm	No. 4	
0-20	2.38 mm	No. 8	8 mesh

Redwood Sawdust
Dry bulk density, lbs. per cu. yd., 260-280

Nitrogen stabilized - dry weight basis, min. 0.4%
Salinity (ECe): 4.0 maximum
Organic Content: 90% minimum
Reaction (pH): 4.0 minimum

Ground Fir and/or Pine Bark
Dry bulk density, lbs. per cu. yd., Min. 350
Nitrogen stabilized - dry weight basis, min. 0.5%
Salinity (ECe): 4.0 maximum
Organic Content: 90% minimum
Reaction (pH): 4.0 minimum

B. Submit sample, product's technical data sheet, and analysis report from an approved soils laboratory for approval by the Engineer. The analysis report should include compliance to the specifications above and directions for product use.

2.3 PLANTS

A. Plant the variety, quantity and size indicated on drawings. The total quantities indicated on the drawings are considered approximate and furnished for convenience only. Contractor shall perform plant quantity calculations and provide all plants shown on the drawings.

B. Measure trees with branches in normal position. Height and spread dimensions indicated refer to the main body of the plant, and not from branch tip to tip.

C. Take precautions to ensure that the plants will arrive at the site in proper condition for successful growth. Protect plants in transit from windburn and sunburn. Protect and maintain plants on site by proper storage and watering.

D. Install healthy, shapely and well rooted plants with no evidence of having been root-bound, restricted or deformed.

E. Tag plants of the type or name indicated and in accordance with the standard practice recommended by the American Association of Nurserymen.

F. Substitutions will not be permitted, except as follows:

1. If proof is submitted to the Engineer that any plant specified is not obtainable, a proposal will be considered for use of nearest equivalent size or variety with an equitable adjustment of contract price.

2. Substantiate and submit proof of plant availability in writing to the Engineer within 10 days after the effective date of Notice to Proceed.

G. Tree Form

1. Trees shall have a symmetrical form as typical for the species/cultivar and growth form.

2. Central Leader for Single Trunk Trees: Trees shall have a single, relatively straight central leader and tapered trunk, free of co-dominant stems and vigorous,

upright branches that compete with the central leader. Preferably, the central leader should not have been headed; however, in cases where the original leader has been removed, an upright branch at least ½ the diameter of the original leader just below the pruning point shall be present.

3. Potential Main Branches: Branches shall be evenly distributed radially around and appropriately spaced vertically along the trunk, forming a generally symmetrical crown typical for the species.

4. Headed temporary branches should be distributed around and along the trunk as noted above and shall be no greater than 3/8" diameter, and no greater than ½ diameter of the trunk at point of attachment.

H. Tree Trunk

1. Trunk diameter and taper shall be sufficient so that the tree will remain vertical without the support of a nursery stake.

2. Trunk shall be free of wounds (except properly-made pruning cuts), sunburned areas, conks (fungal fruiting-bodies), wood cracks, bleeding areas, signs of boring insects, galls, cankers and/or lesions.

3. Tree trunk diameter at 6" above the soil surface shall be within the diameter range shown for each container size below, except where shown otherwise:

Container	Trunk Diameter	Soil level from Container Top
15 Gal	3/4" to 1-1/4"	1-3/4" to 2-3/4"

4. Tree trunks shall be undamaged and uncut with all old abrasions and cuts completely callused over. Do not prune plants prior to delivery.

I. Tree Roots

1. Trunk root collar (root crown) and large roots shall be free of circling and/or kinked roots. Contractor may be required to remove soil near the root collar in order to verify that circling and/or kinked roots are not present.

2. The tree shall be well rooted in the container. When the trunk is lifted the trunk and root system shall move as one and the rootball shall remain intact.

3. The top-most roots or root collar shall be within 1" above or below the soil surface. The soil level in the container shall be within the limits shown in above table.

4. The rootball periphery shall be free of large circling and bottom-matted roots.

5. On grafted or budded trees, there shall be no suckers from the root stock.

2.4 TURF GRASS

A. Turf Seed:
At least 98% pure, weed-free mixture and a minimum of 85% germination, recleaned,

Grade A "new Crop" seed, delivered in the original containers, unopened and bearing a guaranteed analysis and dealer's label. Mixture as follows:

New Century Fescue Blend with Blue Seed Rate: 435 Lbs/Acre
45% Bonsai 2000 Ultra Dwarf Tall Fescue
45% Millennium Ultra Dwarf Tall Fescue
5% Moonlight Kentucky Bluegrass
5% Northstar Kentucky Bluegrass

2.5 HYDROSEED MULCH WITH TACKIFIER

A. Conwed Hydro Mulch 1000 or equal Buffalo Grove, IL, (800) 366-1180; and Hydrostraw or equal, Hydrostraw LLC, Rockford, WA, (800) 545-1755; fibrous, wood cellulose with tackifier containing no growth or germination inhibiting factors and manufactured in such a manner that after addition and agitation in slurry tanks with fertilizer, seed, water and other approved additives, the fibers in the material become uniformly suspended to form a homogeneous slurry; and that when hydraulically sprayed on the ground, the material forms a blotter-like ground cover impregnated uniformly with seed; and which, after application, allows the absorption of moisture and rainfall to percolate to the underlying soil. The fibrous mulch in its air-dry state shall contain not more than 15% by weight of water. The fiber shall have a temporary green dye and shall be accompanied by a certificate of compliance stating that the fiber conforms to these specifications.

B. The Tackifier/Stabilizer shall be an organic substance supplied in powder form and shall be psilium-based and packed in clearly marked bags stating the contents of each package. The California Department of Food and Agriculture shall certify the material as an Auxiliary Soil Chemical.

2.6 HUMATE FOR HYDROSEED

A. Shall be Organic Materials Review Institute (OMRI) listed and contain a least 40% Humic Acid. It shall be a natural granual humic acid based material that functions as an organic chelator and microbial stimulator. Humate shall not burn the plant material, is non-toxic and non-staining.

Humate Soil Conditioner

Humic Acids (from Leonardite)	40.00%
Organic Matter	40.00% – 50.00%
Carbon	50.00% – 60.00%
Nitrogen	0.05% - 1.00%
Phosophoric Acid	0.07%
Potash	0.13%
Sulfur	0.21%

Magnesium	0.18%
Calcium	0.32%
pH	4.0
Soluble Salts	1.8

2.7 FERTILIZERS

A. General Landscape Fertilizers
Commercial fertilizer, pelleted or granular form, conform to the requirements of Chapter 7, Article 2, of the Agricultural Code of the State of California for fertilizing materials as follows:

Type A:
6% Nitrogen, 20% Phosphorus Acid and 20% Potash, (6-20-20)

Type B:
21 gram planting tablets 20% Nitrogen, 10% Phosphoric Acid and 5% Potash (20-10-5) available from Agriform or 10gm BestPacks packets 20% Nitrogen, 10% Phosphoric Acid and 5% Potash (20-10-5) available from Best Fertilizer Co.

Type C (Maintenance Fertilizer)
Complete fertilizer 21% Nitrogen, 7% Phosphoric Acid and 14% Potash (21-7-14)

1. If commercial fertilizer having the above analysis is not obtainable, other similar commercial fertilizer may be used providing it meets the approval of the Engineer.

2.8 IRON SULFATE: DRY FORM.

2.9 PRE-EMERGENCE WEED KILLER

A. Clean non-staining as recommended by a licensed pest control specialist.

2.10 TREE STAKES

A. Lodge pole pine logs, clean, smooth, un-treated.

B. Unless otherwise shown on drawings, provide three-inch (3") diameter by eight to ten feet (8' - 10') long for trees greater than 8' high and 1" caliper.

C. 3” O.D. Lodge pole tree stakes, painted black

2.11 TREE TIES

A. Unless otherwise shown on drawings, provide rubber strap, 24-inch minimum length without sharp edges adjacent to trunk, V.I.T. cinch-tie, Dublin, CA, (818)882-9530, or approved equal.

B. Black corded rubber tree ties w/ clips by greensleeves.com

PART 3 EXECUTION

3.1 PLANT PROTECTION AND REPLACEMENT

A. Inspect and protect all existing and new plants and trees against damage from construction activities, erosion, trespass, insects, rodents, deer, disease, etc. and provide proper safeguards, including trapping of rodent and applying protective sprays and fencing to discourage deer browsing. Maintain and keep all temporary barriers erected to prevent trespass.

B. Repair all damaged planted areas. Replace plants and re-seed or re-sod turf immediately upon discovery of damage or loss.

3.2 LIME TREATED SOIL

A. If site work includes Lime Treatment of the subsoil, the Contractor shall remove full depth of treated soil beyond 12” from structure(s) and replace with approved planting soil.

B. Following removal of lime treated material, scarify subgrade to a minimum depth of 6 inches and test for drainage.

C. Test subgrade in all planting areas for drainage by flooding with minimum 4-inch depth of water puddle and verify complete absorption of standing water within two hours. If standing water is still present after two hours, provide perforated pipe and drain rock "French Drain" system in bottom of non-draining planters and connect to storm drainage system, as accepted by Engineer prior to backfilling with approved planting soil.

3.3 GENERAL PREPARATION OF PLANTING SOIL

A. Submit soil analysis report of amended soils from an approved soils laboratory for approval by the Engineer. Refer to Part 1 for soil testing requirements.

B. All planting soils to be amended as specified in soil laboratory analysis report(s).

C. Provide a minimum of 12” depth of amended planting soil in all planting areas, or more where shown or specified otherwise. Install soil in maximum 12” lifts. Compact each lift prior to installing subsequent lifts.

D. Thoroughly wet down the planting areas to settle the soil and confirm irrigation coverage and operation. Allow soil to dry so as to be workable as described herein.

E. After the rototill work, float areas to a smooth, uniform grade as indicated on the drawings. Slope all planting areas to drain. Roll, scarify, rake and level as necessary to

obtain true, even planting surfaces. Remove rocks, sticks and debris 1 inch and larger in size in turf areas. Secure approval of the grade by the Engineer before any planting.

F. Prior to planting, soil shall be loose and friable to a minimum depth of 12” with a relative maximum compaction of 85%. Rip and scarify any overly compacted and re-compacted planting areas (in two directions full depth of compacted soil) prior to planting.

G. Water settling, puddling, and jetting of soil and backfill materials as a compaction method is not acceptable.

H. Prior to planting, soil shall be moist, but not so moist that it sticks to a hand shovel. Do not work planting soil in a wet or muddy condition or dump or spread in areas where subgrade is not in proper condition.

I. Provide planting soil as a final lift in all planting areas within and adjacent to paved areas and other construction where native site soil has been covered by engineered fill and/or base rock. Unless otherwise shown or specified, finish grade in planting islands shall be crowned with a minimum 2% pitch to drain.

J. Finish Grade: Hold finish grade and/or mulch surface in planting areas1/2-inch below adjacent pavement surfaces, tops of curbs, manholes, etc. The subgrade of the mulch in mulched planting areas shall be a minus 2 inches at a distance of 12 to 18 inch from the edge of pavement. Drag finish grade to a smooth, even surface. Grade to form all swales and berms. Pitch grade with uniform slope to catch basins, streets, curb, etc., to ensure uniform surface drainage. Areas requiring grading include adjacent transition areas that shall be uniformly sloped between finish elevations. Slope surface away from walls so water will not stand against walls or buildings. Control surface water to avoid damage to adjoining properties or to finished work on the site. Take required remedial measures to prevent erosion of freshly graded areas.

K. Planting operations shall be performed only during periods when beneficial results can be obtained. When excessive moisture or other unsatisfactory conditions prevail, the work shall be stopped until conditions are satisfactory.

3.4 PREPARATION OF IN-SITU PLANTING SOIL

A. In-Situ Planting Soil is defined as top soil left in its original place and undisturbed during construction activities which is to receive new planting

B. Except within tree driplines, rip all planting areas in two directions full depth to a minimum of 12” into undisturbed native subsoil prior to amending. Scarification of any planting area which cannot be accomplished with a tractor shall be accomplished by an alternative method approved by the Engineer to the specified depth to ensure proper percolation/drainage.

C. Inspect planting areas and remove all base rock and other foreign material. Verify placement of planting soil within dripline of trees with Engineer.

D. Test depth of loose soil with hand shovel in presence of Engineer in several locations as directed.

E. After acceptance of the planting condition, uniformly mix and amend soil with required fertilizers, nutrients, etc. per specifications herein and recommendations given in soils reports.

F. In the case of a contradiction between the quantity of organic amendment required by the soils laboratory analysis and the specified quantity below, the greater of the two quantities shall take precedence.

1. Spread organic amendment, iron and Type A fertilizer evenly over installed and rough graded on-site topsoil in all planting areas including turf areas at the following rates:

   a. Organic Amendment: 6 cubic yards per 1,000 square feet
   b. Fertilizer: Type A (6-20-20) at 20 lbs. per 1,000 square feet.
   c. Iron Sulfate: 10 lbs. per 1,000 square feet

2. Rototill above additives into soil 8 inches deep. Keep iron sulfate off pavement and other surfaces to prevent rust staining. Correct all rust damage to work.

3. Final planting soil shall have a pH range of 6.5 to 7.5.

3.5 PRE-EMERGENCE WEED KILLER

A. Work shall be done under the supervision of a person licensed by the State of California as a pest control applicator and holding a qualified applicator license or a Qualified Applicator Certificate.

B. Apply pre-emergence weed killer in all areas to receive ground cover planting. Obtain approval of the finish grades prior to applying weed killer and coordinate planting and watering with the pest control specialist prior to planting. Take care to keep weed killer off areas to be seeded.

3.6 TREE PLANTING

A. Mark tree locations on site using stakes, gypsum or similar approved means and secure location approval by the Engineer before plant holes are dug. Adjust location as required prior to planting.

B. Review location of plants in relationship to irrigation heads and adjust location(s) that interfere with the function of the spray heads. Adjust locations as required to ensure that the plant roots receive the proper amount of water in order for the plants to thrive.

C. Excavate tree pits as follows:

	Width	Depth
Trees	Container + 24"	Container depth

D. Test drainage of plant beds and tree pits by filling with water (minimum 6"). The retention of water in planting beds and plant pits for more than two (2) hours shall be brought to the attention of the Engineer. If rock, underground construction work, tree roots, poor drainage, or other obstructions are encountered in the excavation of plant pits, alternate locations may be selected by Engineer.

E. Break and loosen the sides and bottom of tree pits to ensure root penetration and water test hole for drainage as required above.

F. Excavate plant hole or tree pit keeping excavated planting soil layer on the surface when backfilling around the plant. Carefully set plants as detailed without damaging the rootball. Superficially cut edge roots vertically on three sides. Remove bottom of plant boxes before planting. Remove sides of boxes after positioning the plant and partially backfilling.

G. Set plants in backfill with top of the rootball 1 inch above finished grade of adjacent soil. Backfill remainder of hole and soak thoroughly by jetting with a hose and pipe section. Water backfill until saturated the full depth of the hole.

H. Backfill plant holes with mix as specified, free from rocks, clods or lumpy material. Backfill native soil free of soil amendments under rootball and foot tamp to prevent settlement. Backfill remainder of the hole with soil mix and place plant tablets or packets (Type B fertilizer) 3 inches below finish grade and 1/2-inch from roots at the following rates:

15 gallon can plant - 6 tablets or packet

I. Except for acid loving plants (Azaleas, Rhododendrons, Ferns, Camellias, etc.), use a soil mix of 2 parts soil from the hole, and 1-part amendment with iron added at the following rates:

15 gallon can plants - iron, 1/2 cup

1. Mix the iron, amendment and soil thoroughly for use in the top 8 inches of backfill around plants. For acid loving plants, mixture to be 1/2 soil from the hole and 1/2 amendment.

J. Remove any soil from top of plant rootballs and secure Engineer's approval of rootball height prior to mulching.

K. After approval of rootball height, install mulch as required below.

L. Stake and/or guy trees as detailed. Drive stake(s) until solid (at least 12" beyond bottom of rootball) and remove excess stake protruding above top tree tie to prevent rubbing against branches. Avoid driving stakes through rootball. If subgrade does not accept stakes to a stable degree, delete stakes and guy the trees as specified herein and as detailed. Locate tree ties to avoid contact with tree branches. Locate top tie at tree flex point.

3.7 SEEDED TURF PLANTING

A. Lightly roll surface and reshape to level humps and hollows. Secure the Engineer's approval before seeding.

B. Sow seed at rate noted above. Use an approved seeding method, sowing one-half of the amount in one direction and the remaining one-half in a direction of 90 degrees to the first during a windless period. Rake lightly to cover seed. Hydroseeding is also an acceptable turf seeding method.

C. Wet seeded areas slowly but thoroughly and keep moist, but not saturated, at all times until the grass has germinated.

3.8 WATERING

A. Water all trees immediately after planting. Apply water to all plants as often and in sufficient amount as conditions may require to keep the plants in a healthy vigorous growing condition until completion of the Contract. Provide supplemental hand watering of trees, as required, to maintain a moist root zones throughout plant establishment period.

3.9 PRE-MAINTENANCE PERIOD REVIEW AND APPROVAL OF PLANTING

A. Maintain plants from time of delivery to site until final acceptance of landscape installation.

B. Receive approval of the installed planting prior to commencement of planting establishment maintenance period. Notify the Engineer a minimum of seven (7) days prior to requested review. Before the review, complete the following:

1. Complete all construction work.

2. Present all planted areas neat and clean with all weeds removed and all plants installed and appearing healthy.

3. Plumb all trees and tree supports.

4. No partial approvals will be given.

3.10 PLANTING ESTABLISHMENT MAINTENANCE

A. General Requirements:

1. Maintenance Period: The planting establishment maintenance period required shall be 120 calendar days after all planting and irrigation is complete, turf is installed/seeded, and as approved by Engineer. A longer period may be required if the turf is not thick, vigorous and even and has been mowed a minimum of 4 times, or if the plant material is not acceptably maintained during the maintenance period. The start of the maintenance period to be confirmed by Engineer. Contractor to notify Engineer of start and end dates of maintenance period. The maintenance period may be suspended at any time upon written notice to the Contractor that the landscaping is not being acceptably maintained, and the day count suspended until the landscape is brought up to acceptable standards as determined by the Owner Representative.

2. Planting establishment maintenance immediately follows, coincides with, and is continuous with the planting operations, and continues through turf installation, and after all planting is complete and accepted; or longer where necessary to establish acceptable stands of thriving plants.

3. Protect all areas against damage, including erosion, trespass, insects, rodents, disease, etc. and provide proper safeguards. Maintain and keep all temporary barriers erected to prevent trespass.

4. Keep all walks and paved areas clean. Keep the site clear of debris resulting from construction or maintenance activities.

5. Repair all damaged planted areas, and replace plants and resod turf immediately upon discovery of damage or loss.

6. Check irrigation systems at each watering; adjust coverage and clean heads immediately. Adjust timing of irrigation controller to prevent flooding.

7. Maintain adequate moisture depth in soil to ensure vigorous growth. Check rootball of trees independent of surrounding soils and hand water as required.

8. Keep contract areas free from weeds by cultivating, hoeing or hand pulling. Use of chemical weed killers will not relieve the Contractor of the responsibility of keeping areas free of weeds at all times.

B. Tree and Plant Maintenance

1. Maintain during the entire establishment period by regular watering, cultivating, weeding, repair of stakes and ties, and spraying for insect pests. Prune when requested by the Engineer.

2. Keep watering basins in good condition and weed-free at all times.

3. Replace all damaged, unhealthy or dead trees with new stock immediately; size as indicated on the drawings.

C. Turf Maintenance

1. Maintain during the entire establishment period. Cut as frequently as growth of grass requires. Cut to a height of two inches (2"), unless otherwise directed by the Engineer.

2. Maintain constant moisture to a depth of eight inches (8").

3. Trim edges of turf at paving at time of second cutting, and at each later cutting.

4. Keep a 2-foot diameter area at tree trunk free of turf at all times to serve as a mowing band. Do not create low area around base of tree.

5. Keep turf areas free of undesirable weeds and grasses by the application of suitable selective weed killers or hand pulling.

6. Re-seed any turf areas damaged by construction activities as soon as evident.

7. Repair any gaps, hollow, settled or eroded areas by filling, rolling and re-sodding.

D. Fertilizing

1. Upon approval and after submitting fertilizer delivery tags, maintenance fertilization shall begin 30 days after planting is complete. Fertilize all turf areas by broad-casting Type C (21-7-14) fertilizer at the rate of 5 lbs. per 1,000 square feet evenly throughout. Reapply every forty-five (45) days until acceptable.

2. During the winter, for quick turf greening effect, calcium nitrate (15.5-0-0) may be applied at the rate of 6 lbs. per 1,000 square feet.

3. Early spring and fall substitute a complete fertilizer such as 15-15-15 applied at the rate of 6 lbs. per 1,000 square feet, to help insure continuing adequate phosphorus and potassium.

4. Apply ammonium sulfate fertilizer as necessary to maintain vigorous, green grass between fertilizations mentioned above.

5. Observe plant's color, and if a soil pH imbalance is suspected, take soil samples and obtain laboratory analysis for confirmation. Take necessary action recommended in laboratory analysis such as top dressing with soil sulfur, leaching soil, etc.

3.11 FINAL PLANTING REVIEW AND ACCEPTANCE

A. At the conclusion of the Maintenance Period, schedule a final review with the Owner, the Owner's maintenance person, and/or the Engineer. On such date, all project improvements and all corrective work shall have been completed. If all project improvements and corrective work are not completed, continue the planting establishment maintenance period at no additional cost to the Owner until all work has been completed. This condition will be waived by the Owner under such circumstances wherein the Owner has granted an extension of time to permit the completion of a particular portion of the work beyond the time of completion set forth in the Agreement.

B. Submit written notice requesting review at least 10 days before the anticipated review.

C. Prior to review, weed and restore all planted areas, mow and edge turf, plumb trees and tree supports, clear the site of all debris and present in a neat, orderly manner.

END OF SECTION

SECTION 03100 – CONCRETE FORMS AND ACCESSORIES

PART 1 GENERAL

1.1 THE REQUIREMENT

A. Furnish all labor, materials, equipment, and incidentals required, and design, install, and remove formwork for cast-in-place concrete as shown on the Drawings and as specified herein.

B. Secure to forms as required or set for embedment as required, all miscellaneous metal items, sleeves, reglets, anchor bolts, inserts, and other items furnished under other Sections and required to be cast into concrete.

1.2 REFERENCE SPECIFICATIONS, CODES, AND STANDARDS

A. American Concrete Institute (ACI)

1. ACI 117 – Standard Specifications for Tolerances for Concrete Construction and Materials

2. ACI 301 – Specifications for Structural Concrete

3. ACI 318 – Building Code Requirements for Structural Concrete

4. ACI 347 – Guide to Formwork for Concrete

B. American Plywood Association (APA)

1. APA – Material Grades and Designations as Specified

C. Where reference is made to one of the above standards, the revision in effect at the time of bid opening shall apply.

1.3 CONTRACTOR SUBMITTALS

A. Submit to the ENGINEER, in accordance with Division 1, shop drawings and product data showing materials of construction and details of installation for the following:

1. Form release agent

2. Form ties

3. Form Liner(s)

4. Bond breakers

B. Falsework and Drawings – The CONTRACTOR will adhere to the provisions of Section 1717 of the Division of Industrial Safety, Construction Safety Orders, which require that all falsework or vertical shoring installations where the height of the falsework or vertical shoring, as measured from the top of the sills to the soffit of the superstructure, exceeds 14 feet, or where individual horizontal span lengths exceed 16 feet, or provision for vehicular or railroad traffic through falsework or vertical shoring is made, shall be approved and signed by a Professional Civil Engineer, registered in the State of California. A copy of the falsework plan or shoring layout shall be available on the job site at all times.

C. The CONTRACTOR shall, in accordance with the requirements in Division 1, submit detailed plans of falsework proposed to be used. Such plans shall be in sufficient detail to indicate the general layout, sizes of members, anticipated stresses, grade of materials to be used in the falsework, and typical soil conditions.

D. Location and sequence of the concrete placement – Indicate locations of form joints, form-tie layout, panel sizes, and patterns.

E. Review of pour sequence, form system, and panel layout shall be for appearance and conformance to design concept only. ENGINEER's review of the forming plans or procedures shall not relieve the CONTRACTOR of responsibility for the strength, safety, or correctness of methods used, the adequacy of equipment, or from carrying out the work in full compliance with the requirements of the Drawings and as specified herein.

F. Samples:

1. The CONTRACTOR shall construct one sample concrete wall 6'-0" high by 6'-0" long with the architectural forms and form liner, complete with the form tie pattern and finish as specified. The wall will be viewed by the ENGINEER in the presence of the CONTRACTOR noting specific defects and establishing the quality of finished architectural concrete for the project. The wall as modified by the ENGINEER's comments shall serve as the standard against which the acceptability of the actual architectural concrete will be judged. The wall shall remain until all architectural concrete has been placed and finished, and accepted at which time the CONTRACTOR shall demolish the wall and remove the debris from the site.

1.4 QUALITY ASSURANCE

A. The form liner manufacturer's representative shall be on-site during initial installation of the form liner to instruct the CONTRACTOR on the proper methods of application and use of the liner. S/He shall be available to answer any questions on the liner that the ENGINEER may have.

1.5 SYSTEM DESCRIPTION

A. General – Architectural Concrete is wall, slab, beam, or column concrete that will have surfaces exposed to view in the finished work. It includes similar exposed surfaces in water containment structures from the top of the walls to 2 feet below the normal water surface in open tanks and basins.

B. Structural Design Responsibility – All forms and shoring shall be designed at the CONTRACTOR's expense by a Professional Civil Engineer, registered in the State of California. Formwork shall be designed and erected in accordance with the requirements of ACI 301 and ACI 318 and as recommended in ACI 347 and shall comply with all applicable regulations and codes.

PART 2 PRODUCTS

2.1 GENERAL

A. The use of a manufacturer's name and model or catalog number is for the purpose of establishing the standard of quality and general configurations desired.

2.2 MATERIALS

A. Forms for cast-in-place concrete shall be made of wood, metal, or other approved material. Wood forms for the project shall be new and unused. Construct wood forms of sound lumber or plywood of suitable dimensions and free from knotholes and loose knots. Where used for exposed surfaces, dress and match boards. Sand plywood smooth and fit adjacent panels with tight joints. Metal forms may be used when approved by the ENGINEER and shall be of an appropriate type for the class of work involved. All forms shall be designed and constructed to provide a flat, uniform concrete surface requiring minimal finishing or repairs.

B. Wall Forms:

1. Forms for all exposed exterior and interior concrete walls shall be new and unused "Plyform" exterior grade plywood panels manufactured in compliance with APA and bearing the trademark of that group, or equal acceptable to the ENGINEER. Provide B grade or better veneer on all faces to be placed against concrete during forming. The class of material and grades of interior plies shall be of sufficient strength and stiffness to provide a flat, uniform concrete surface requiring minimal finishing and grinding.

2. All joints or gaps in forms shall be taped, gasketed, plugged, and/or caulked with an approved material so that the joint will remain watertight and will withstand placing pressures without bulging outward or creating surface patterns.

3. Forms for circular structures shall conform to the circular shape of the structure. Straight panels may be substituted for circular panels if the straight panels do not exceed 2-ft in width nor deflect more than 3-1/2 degrees per joint, nor conflict with specific notes on the Drawings.

C. Column Forms:

1. Rectangular columns shall be formed as specified for wall forms. All corners shall have a 3/4-inch chamfer unless otherwise noted on the Drawings.

2. Circular columns shall be formed with steel, fiberglass-reinforced plastic, or seamless cardboard column forms. The forms shall be continuous for the height of the column between construction joints indicated on the Drawings unless otherwise approved by the ENGINEER.

D. Rustications shall be at the location and shall conform to the details shown on the Drawings. Moldings for chamfers and rustications shall be milled and planed smooth. Rustications and corner strips shall be of a nonabsorbent material, compatible with the form surface and fully sealed on all sides to prohibit the loss of paste or water between the two surfaces.

E. Form Release Agent – Coat all forming surfaces in contact with concrete using an effective, nonstaining, non-residual, water-based, bond-breaking form coating, unless otherwise noted.

F. Forms for Architectural Concrete.

1. Forms for architectural concrete shall be constructed of materials and in a manner that will result in rigid forms with sufficient strength to withstand, without noticeable deflection, movement, or leakage, the high hydraulic pressures resulting from rapid filling of the forms and heavy, high-frequency vibration of the concrete. Deflection in formwork shall be limited to 1/360 of each component span. Form joints shall be laid out in a uniform pattern or as indicated on the Drawings.

G. Form Liner(s)

1. The ribbed texture indicated on the Drawings shall be Dover Rib, by Spec Formliners, Inc.; Pattern No. 1106 or approved equal.

H. Form Ties:

1. Form ties encased in concrete other than those specified in the following paragraphs shall be designed so that, after removal of the projecting part, no metal shall remain within 1 1/2 inches of the face of the concrete. The part of the tie to be removed shall be at least 1/2 inch in diameter or be provided with a wood or metal cone at least 1/2 inch in diameter and 1 1/2 inches long. Form ties in concrete exposed to view shall be the cone-washer type.

2. Form ties for exposed exterior and interior walls shall be as specified in the preceding paragraph except that the cones shall be approved wood or plastic.

3. Flat bar ties for panel forms shall have plastic or rubber inserts having a minimum depth of 1 1/2 inches and sufficient dimensions to permit proper patching of the tie-hole.

4. Ties for liquid containment structures shall have a neoprene washer at the center of the tie. Snap-Ties shall be Meadow Burke, Tampa, FL, Gates & Sons, Inc., Denver, CO, or approved equal.

5. Common wire shall not be used for form ties.

6. Alternate form ties, consisting of tapered through-bolts at least 1 inch in diameter at the smallest end or through-bolts that utilize a removable tapered sleeve of the same minimum size, may be used at the CONTRACTOR's option. Obtain ENGINEER's acceptance of system and spacing of ties before ordering or purchasing of forming. Clean, fill, and seal form tie hole with nonshrink cement grout. The CONTRACTOR shall be responsible for watertightness of the form ties and any repairs needed.

PART 3 EXECUTION

3.1 GENERAL

A. Forms shall be used for all cast-in-place concrete including sides of footings. Forms shall be constructed and placed so that the resulting concrete will be of the shape, lines, dimensions, and appearance indicated on the Drawings.

B. Forms for walls shall have removable panels at the bottom for cleaning, inspection, and joint surface preparation. Forms for wall heights in excess of 16 feet shall have closable intermediate inspection ports. Tremies and hoppers for placing concrete shall be used to allow concrete inspection, prevent segregation, and prevent the accumulation of hardened concrete on the forms above the fresh concrete.

C. Molding, bevels, or other types of chamfer strips shall be placed to produce blockouts or chamfers as shown on the Drawings or as specified herein. Chamfer strips shall be provided at horizontal and vertical projecting corners to produce a 3/4-inch chamfer. Rectangular or trapezoidal moldings shall be placed in locations requiring sealants where specified or shown on the drawings. Size of moldings shall conform to the sealant manufacturer's recommendations.

D. Forms shall be sufficiently rigid to withstand construction loads and vibration and to prevent displacement or sagging between supports. Construct forms such that the concrete and/or exposed rebar (dowels) will not be damaged by their removal. The CONTRACTOR shall be entirely responsible for the adequacy of the forming system.

E. Before form material is reused, all surfaces to be in contact with concrete shall be thoroughly cleaned, all damaged places repaired, all projecting nails withdrawn, and all protrusions smoothed. Reuse of wooden forms for other than rough finish will be permitted only if a "like-new" condition of the form is maintained.

F. Metal items, such as rebar, wire, or plates used to support pipe penetrations and pipe embedment shall have a minimum clearance of 2 inches from reinforcing bars.

G. Tolerances in concrete construction shall be in accordance with ACI 117, unless otherwise noted.

3.2 FORM TOLERANCE

A. Forms shall be surfaced, designed, and constructed in accordance with the recommendations of ACI 347 and shall meet the following additional requirements for specified finishes.

B. Formed Surfaces Exposed to View – Edges of all form panels in contact with concrete shall be flush within 1/32 inch and forms for plane surfaces shall be such that the concrete will be plane within 1/16 inch in 4 feet. Forms shall be tight to prevent the passage of mortar, water, and grout. The maximum deviation of the finish wall surface at any point shall not exceed 1/4 inch from the intended surface as shown on the Drawings. Form panels shall be arranged symmetrically and in an orderly manner to minimize the number of seams.

C. Formed surfaces not exposed to view or buried shall meet the requirements of Class "C" Surface in ACI 347.

D. Formed rough surfaces including mass concrete, pipe encasement, electrical duct encasement, and other similar installations shall have no minimum requirements for surface smoothness and surface deflections. The overall dimensions of the concrete shall be plus or minus 1 inch.

E. Architectural Concrete – All smooth faces to be exposed to view shall have surface deflections limited to 1/32 inch at any point and the variation in wall deflection shall not exceed 1/16 inch per 4 feet. The maximum deviation of the finished wall surface at any point shall not exceed 1/4 inch from the intended surface as shown on the Drawings. All textured faces, form lines, or rustications to be exposed to view shall be straight, plumb, and true with a variation of no more than ¼ inch in 10 feet measured in any direction.

3.3 FORM PREPARATION

A. Wood forms in contact with concrete shall be coated with an effective release agent before form installation.

B. Steel forms shall be thoroughly cleaned and mill scale and other ferrous deposits shall be sandblasted or otherwise removed from the contact surface for all forms except those utilized for surfaces receiving a rough finish. All forms shall have the contact surfaces coated with a release agent.

C. Form liners to be installed for architectural concrete finish shall be in accordance with the manufacturer's recommendations.

3.4 REMOVAL OF FORMS

A. The CONTRACTOR shall be responsible for all damage resulting from removal of forms. Form removal shall conform to the requirements specified in Section 03300.

3.5 INSPECTION

A. The ENGINEER shall be notified when the forms are complete and ready for inspection at least 24 hours before the proposed concrete placement.

B. Failure of the forms to comply with the requirements specified herein, or to produce concrete complying with the requirements of this Section, shall be grounds for rejection of that portion of the form/concrete work. Rejected work shall be repaired or replaced as directed by the ENGINEER at no additional cost to the CITY. Such repair or replacement shall be subject to the requirements of this Section and approval of the ENGINEER.

3.6 FALSEWORK

A. The CONTRACTOR shall be responsible for the design, engineering, construction, maintenance, and safety of all falsework, including staging, walkways, forms, ladders, and similar appurtenances, which shall equal or exceed the applicable requirements of the provisions of the OSHA Safety and Health Standards for Construction, the requirements of the Construction Safety Orders of the California Division of Industrial Safety, and the requirements specified herein.

B. All falsework shall be designed and constructed to provide the necessary rigidity and to support the loads. Falsework for the support of a superstructure shall be designed to support the loads that would be imposed if the entire superstructure were placed at one time.

C. Falsework shall be placed upon a solid footing, safe against undermining, and protected from softening. When the falsework is supported on timber piles, the maximum calculated pile loading shall not exceed 20 tons. When falsework is supported on any portion of the structure that is already constructed, the loading imposed by the falsework shall be spread, distributed, and braced in such a way as to avoid any possibility of damage to the structure.

END OF SECTION

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SECTION 03150 – CONCRETE JOINTS AND ACCESSORIES

PART 1 GENERAL

1.1 THE REQUIREMENT

A. Furnish all labor, materials, equipment, and incidentals required and install accessories for concrete joints as shown on the Drawings and as specified herein.

1.2 REFERENCE SPECIFICATIONS, CODES, AND STANDARDS

A. Federal Specifications

1. SS-S-210A – Sealing Compound, Preformed Plastic, for Expansion Joints and Pipe Joints

B. ASTM International (ASTM)

1. ASTM A675 – Standard Specification for Steel Bars, Carbon, Hot-Wrought, Special Quality, Mechanical Properties

2. ASTM C881 – Standard Specification for Epoxy-Resin-Base Bonding Systems for Concrete

3. ASTM C1059 – Standard Specification for Latex Agents for Bonding Fresh to Hardened Concrete

4. ASTM D1751 – Standard Specification for Preformed Expansion Joint Filler for Concrete Paving and Structural Construction (Non-extruding and Resilient Bituminous Types)

5. ASTM D1752 – Standard Specification for Preformed Sponge Rubber and Cork and Recycled PVC Expansion Joint Fillers for Concrete Paving and Structural Construction

C. US Army Corps of Engineers (CRD)

1. CRD-C 572 – Specification for Polyvinylchloride Waterstops

D. Where reference is made to one of the above standards, the revision in effect at the time of bid opening shall apply.

1.3 CONTRACTOR SUBMITTALS

A. Submit to the ENGINEER, in accordance with Division 1, submittals including the following:

1. Waterstops – Product data including catalogue cut, technical data, storage requirements, splicing methods, and conformity to ASTM standards.

2. Premolded Joint Fillers – Product data including catalogue cut, technical data, storage requirements, installation requirements, location of use, and conformity to ASTM standards.

3. Bond Breaker – Product data including catalogue cut, technical data, storage requirements, installation requirements, location of use, and conformity to ASTM standards.

4. Expansion Joint Dowels – Product data on the complete assembly including dowels, coatings, lubricants, spacers, sleeves, expansion caps, installation requirements, and conformity to ASTM standards.

5. Compressible Joint Filler – Product data including catalogue cut, technical data, storage requirements, installation requirements, location of use, and conformity to ASTM standards.

6. Bonding Agents – Product data including catalogue cut, technical data, storage requirements, product life, application requirements, and conformity to ASTM standards.

7. Samples – Two samples of each type of waterstop fitting(s).

B. Certifications:

1. Certify that all materials used within the joint system are compatible with each other.

PART 2 PRODUCTS

2.1 GENERAL

A. The use of a manufacturer's name and model or catalog number is for the purpose of establishing the standard of quality and general configuration desired.

B. All materials used together in a given joint (bond breakers, backer rods, joint fillers, sealants, etc.) shall be compatible with one another. Coordinate selection of suppliers and products to ensure compatibility. Under no circumstances shall asphaltic bond breakers or joint fillers be used in joints receiving sealant.

C. All chemical sealant type waterstops shall be products specifically manufactured for the purpose for which they will be used and the products shall have been successfully used on similar structures for more than five years.

2.2 MATERIALS

A. Polyvinylchloride (PVC) Waterstops (Standard) – The PVC waterstops shall be made by extruding elastomeric plastic compound with virgin PVC as the basic resins. The compound shall contain no reprocessed materials. Minimum tensile strength of waterstops shall be 1,750 pounds per square inch. The waterstops shall conform to CRD-C 572.

1. Waterstops for expansion joints shall be 9 inches wide and be ribbed type with a center bulb. Expansion joint waterstops shall be style 696 by Greenstreak Corporation, St. Louis, MO; style RLB938 by Vinylex Corporation, Knoxville, TN; or equal.

2. Waterstops for non-expansion joints shall be 6 inches wide and be the flat ribbed type. Non-expansion joint waterstops shall be style 679 by Greenstreak Incorporated, St. Louis, MO; style R638 by Vinylex Corp., Knoxville, TN; or equal. Equal waterstops may have an integral fastening system

B. Preformed Adhesive Waterstops – Provide preformed adhesive waterstops at construction joints between existing concrete or concrete pipe and cast-in-place concrete. The waterstops shall be rope type, preformed plastic waterstops meeting the requirements of Federal Specification SS-S-210A. The rope shall have a cross section of approximately 1 square inch unless otherwise specified or shown on the Drawings. The waterstops shall be SF302 Synko-Flex Waterstop as manufactured by Henry Company, El Segundo, CA or equal. Primer for the material shall be as recommended by the waterstop manufacturer.

C. Premolded Joint Filler:

1. Premolded joint filler for structures shall be self-expanding, cork, premolded joint filler conforming to ASTM D1752, Type III. The thickness shall be 3/4 inch unless shown otherwise on the Drawings.

2. Premolded joint filler for sidewalk and roadway concrete pavements, or where fiber joint filler is specifically noted on the Drawings, shall be asphalt-impregnated fiberboard conforming to ASTM D1751. The thickness shall be 3/4 inch unless otherwise shown on the Drawings.

D. Bond Breaker:

1. Bond breaker tape shall be an adhesive-backed, glazed butyl or polyethylene tape that will satisfactorily adhere to the premolded joint filler or concrete surface as required. The tape shall be the same width as the joint.

2. Except where tape is specifically called for on the Drawings, bond breaker for concrete shall be either bond breaker tape or a nonstaining type bond prevention coating such as Silcoseal Select, by Nox-Crete, Omaha, Nebraska; or equal.

E. Expansion Joint Dowels:

1. Dowels shall be smooth steel conforming to ASTM A675, Grade 70. Dowels must be straight and clean, free of loose, flaky rust and loose scale. Dowels may be sheared to length provided deformation from true shape caused by shearing does not exceed 0.04 inch on the diameter of the dowel and extends no more than 0.04 inch from the end. Bars shall be coated with a bond breaker on the expansion end of the dowel. Expansion caps shall be provided on the expansion end.

2. Expansion dowel caps shall be No. 87 dowel caps as manufactured by Hack Building Products, Inc.; Type F-46 dowel caps as manufactured by the Dayton Sure-Grip and Shore Company; or equal.

F. Bonding Agent:

1. Epoxy bonding agent shall be two-component, solvent-free, moisture insensitive, epoxy resin material conforming to ASTM C881, Type II. The bonding agent shall be Sikadur 32 Hi-Mod by Sika Corporation; Concresive Liquid LPL by BASF Building Systems; or equal.

2. Latex bonding agent shall be non-reemulsifiable acrylic-polymer latex conforming to ASTM C1059, Type II.

G. Compressible Joint Filler:

1. The joint filler shall be a non-extruded, watertight strip material used to fill expansion joints between structures. The material shall be capable of being compressed at least 40 percent for 70 hours at 68 degrees Fahrenheit and subsequently recovering at least 20 percent of its original thickness in the first 1/2 hour after unloading. Compressible joint filler shall be Phyzite/Evazote 380 as manufactured by Chase Construction Products; Wabo Evazote UV as manufactured by BASF Chemical Company; or equal.

PART 3 EXECUTION

3.1 INSTALLATION

A. Standard Waterstop:

1. Install waterstops for all joints where indicated on the Drawings. Waterstops shall be continuous around all corners and intersections so that a continuous seal is provided. All fittings shall be factory made or shop welded in accordance with manufacturer's recommendations. Only straight butt splices shall be fabricated in the field.

2. PVC splices shall be made by welding in accordance with the manufacturer's recommendations, subject to acceptance of the ENGINEER. Only manufacturer's special approved tools shall be used for welding. The finished splices shall provide a cross section that is dense and free of porosity.

3. To properly secure PVC waterstops in wall joints before concrete is placed, center the waterstop in the joint. Clamp both edges of the waterstop and fasten to reinforcing steel with black annealed steel tie wire as specified for tying reinforcing steel and secure in place so that the waterstop will be perpendicular to the joint and will remain in the required position during concrete placement. The spacing of the waterstop ties shall match the spacing of the adjacent reinforcing, but need not be spaced closer than 12 inches on center.

4. Horizontal PVC waterstops in slabs shall have the edge of the waterstop lifted while placing concrete below the waterstop. The waterstop shall then be manually forced against and into the placed concrete and covered with fresh concrete, to ensure adequate encasement of the waterstop in concrete.

5. Each piece of the waterstop shall be of maximum practicable length to provide a minimum number of splices.

6. Waterstops shall be installed so that half of the width will be embedded on each side of the joint. Care shall be exercised to ensure that the waterstop is completely embedded in void-free concrete.

7. Waterstops shall be terminated 3 inches below the exposed top of walls.

B. Construction Joints:

1. Make construction joints only at locations shown on the Drawings or as approved by the ENGINEER. Any additional or relocation of construction joints proposed by the CONTRACTOR must be submitted to the ENGINEER for written approval.

2. All joints shall be perpendicular to main reinforcement. Continue reinforcing steel through the joint as indicated on the Drawings.

3. Provide sealant grooves for joint sealant where indicated on the Drawings.

4. At all construction joints, and at concrete joints designated on the Drawings to be "roughened," uniformly roughen the surface of the concrete to a full amplitude (distance between high and low points or side to side) of approximately 1/4 inch to expose a fresh face. Thoroughly clean joint surfaces of loose or weakened materials by water blasting or sandblasting and prepare for bonding. At least 2 hours before, and again shortly before the new concrete is deposited, saturate the joints and adjacent concrete surfaces to at least 12 inches past the joint with water. At horizontal construction joints for water containment structures, Contractor shall deposit 1/2 to 2 inches of mortar containing the same proportions of cement, sand, and water as used in the approved mix into the forms. Mortar shall be placed immediately before depositing the concrete and shall be plastic (neither stiff nor fluid) when the concrete is placed.

5. In lieu of the above method for bonding plastic concrete to hardened concrete, the following optional method may be used. Concrete must be allowed to set a minimum of 28 days. Use a latex-bonding agent applied to roughened and cleaned surfaces of set concrete in strict accordance with manufacturer's recommendations.

6. Provide waterstops in all wall and slab construction joints in liquid containment structures and at other locations shown on the Drawings.

7. Keyways shall not be used in construction joints unless specifically shown on the Drawings or approved by the ENGINEER.

C. Control Joints:

1. Provide sealant grooves, sealants, and waterstops at control joints in slabs on grade or walls as detailed. Provide waterstops at all wall and slab control joints in water containment structures and at other locations shown on the Drawings.

2. Control joints may be sawed if specifically approved by the ENGINEER. If control joint grooves are sawed, properly time the saw cutting with the time of the concrete set. Start cutting as soon as concrete has hardened sufficiently to prevent aggregates from being dislodged by the saw. Complete cutting before shrinkage stresses have developed sufficiently to induce cracking. No reinforcing shall be cut during sawcutting.

3. Extend every other bar of reinforcing steel through control joints or as indicated on the Drawings. Where specifically noted on the Drawings, coat the concrete surface of the joint with a bond breaker before placing new concrete against the joint. Avoid coating reinforcement or waterstops with bond breaker at these locations.

D. Expansion Joints:

1. Do not extend through expansion joints, reinforcement, or other embedded metal items that are continuously bonded to concrete on each side of the joint.

2. Position premolded joint filler material accurately. Secure the joint filler against displacement during concrete placement and compaction. Place joint filler over the face of the joint, allowing for sealant grooves as detailed on the Drawings. Tape all joint filler splices to prevent intrusion of mortar. Seal expansion joints as shown on the Drawings.

3. Expansion joints shall be 3/4 inch in thickness unless otherwise noted on the Drawings.

END OF SECTION

SECTION 03200 – CONCRETE REINFORCEMENT

PART 1 GENERAL

1.1 THE REQUIREMENT

A. Furnish all labor, materials, equipment and incidentals required and install all concrete reinforcement complete as shown on the Drawings and as specified herein.

1.2 REFERENCE SPECIFICATIONS, CODES, AND STANDARDS

A. Federal Specifications

1. QQ-W-461H – Wire, Steel, and Carbon (round, bare and coated)

B. American Concrete Institute (ACI)

1. ACI 301 – Specifications for Structural Concrete

2. ACI 315 – Details and Detailing of Concrete Reinforcement

3. ACI 318 – Building Code Requirements for Structural Concrete

4. ACI SP-66 – ACI Detailing Manual

C. ASTM International (ASTM)

1. ASTM A615 – Standard Specification for Deformed and Plain Carbon Steel - Bars for Concrete Reinforcement

2. ASTM A706 – Standard Specification for Low-Alloy Steel Deformed and Plain Bars for Concrete Reinforcement

3. ASTM A1064 – Standard Specification for Carbon-Steel Wire and Welded Wire Reinforcement, Plain and Deformed, for Concrete

D. American Welding Society (AWS)

1. AWS D1.4 – Structural Welding Code - Reinforcing Steel

E. Concrete Reinforcing Steel Institute (CRSI)

1. CRSI – Manual of Standard Practice

F. Where reference is made to one of the above standards, the revision in effect at the time of bid opening shall apply.

1.3 CONTRACTOR SUBMITTALS

A. Reinforcing Steel – Submit to the ENGINEER, in accordance with Division 1, placement drawings conforming to the recommendations of ACI 315. All reinforcement in a concrete placement shall be included in a single placement drawing or cross-referenced to the pertinent main placement drawing. The main drawing shall include the additional reinforcement (around openings, at corners, etc.) shown on the standard details sheets. Bars to have special coatings and/or to be of special steel or special yield strength are to be clearly identified.

B. Bar Bending Details – The bars shall be referenced to the same identification marks shown on the placement drawings. Bars to have special coatings and/or to be of special steel or special yield strength shall be clearly identified.

C. Mechanical Connectors – Submit two samples of each type of mechanical reinforcing steel connectors.

D. Test Reports – Submit test reports for each of the following items:

1. Mill Test – Submit a certified copy of a mill test on each steel proposed for use showing the physical properties of the steel and the chemical analysis.

2. Foreign Manufactured Steel – Submit a certified copy of test reports for each foreign manufactured steel proposed for use in the fabrication of reinforcement. The tests shall be specifically made for this project at the expense of the CONTRACTOR by a domestic independent testing laboratory certified to perform the tests. The testing shall be for conformity to the applicable ASTM standard(s).

3. Certified copy of welding test reports for rebar cages fabricated using Schnell IDEA Machine.

E. Certification

1. Submit certification that welders are qualified in accordance with AWS D1.4 when welding of reinforcement is required.

1.4 QUALITY ASSURANCE

A. In no case shall any reinforcing steel be covered with concrete until the installation of the reinforcement, including the size, spacing, and position of the reinforcement has been observed by the ENGINEER and the ENGINEER's release to proceed with concreting has been obtained. The ENGINEER shall be given ample prior notice of the readiness of placed reinforcement for observation. The forms shall be kept open until the ENGINEER has completed observations of the reinforcing steel.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Reinforcing steel shall be substantially free from mill scale, rust, dirt, grease, or other foreign matter.

B. Reinforcing steel shall be shipped and stored with bars of the same size and shape, fastened in bundles with durable tags, marked in a legible manner with waterproof markings showing the same "mark" designations as those shown on the submitted Placement Drawings.

C. Reinforcing steel shall be stored off the ground, protected from moisture, and kept free from dirt, oil, or other injurious contaminants.

PART 2 PRODUCTS

2.1 GENERAL

A. The use of a manufacturer's name and model or catalog number is for the purpose of establishing the standard of quality and general configurations desired.

2.2 MATERIALS

A. Materials shall be new and shall comply with the following material specifications.

B. Deformed concrete reinforcing bars are to be ASTM A706, Grade 60 deformed bars.

C. Spiral Reinforcement shall comply with the following:

1. ASTM A706, Grade 60 for hot-rolled plain or deformed bars

2. ASTM A1064 for cold-drawn wire

D. Welded Steel Wire Fabric shall comply with ASTM A1064.

E. The following alternative materials are allowed:

1. ASTM A615, Grade 60 may be used for ASTM A706 provided the following requirements are satisfied:

a. The actual yield strength of the reinforcing steel based on mill tests shall not exceed the specified yield strength by more than 18,000 pounds per square inch (psi). Retests shall not exceed this value by more than an additional 3,000 psi.

b. The ratio of the actual ultimate tensile strength to the actual tensile yield strength of the reinforcement shall not be less than 1.25.

c. The carbon equivalency of the bars shall be 0.55 or less.

F. Reinforcing Steel Accessories:

1. Plastic protected bar supports shall comply with CRSI Bar Support Specifications, Class 1 - Maximum Protection.

2. Stainless steel protected bar supports shall comply with CRSI Bar Support Specifications, Class 2 - Moderate Protection.

3. Precast concrete block bar supports (dobies) shall comply with CRSI Bar Support Specifications, Precast Block. Block shall have equal or greater compressive strength than the surrounding concrete.

G. Tie Wire:

1. Tie wires for Reinforcement shall be 16-gauge or heavier, black annealed wire, conforming to Federal Specification QQ-W-461H.

H. Mechanical reinforcing steel butt splices shall be positive connecting taper-threaded type employing a hexagonal coupler such as Lenton rebar splices as manufactured by Erico Products, Inc., Solon, OH or equal. They shall meet all ACI 318 Building Code requirements. Bar ends must be taper-threaded with coupler manufacturer's bar threader to ensure proper taper and thread engagement. Bar couplers shall be torqued to manufacturer's recommended value.

1. Unless otherwise noted on the Drawings, mechanical tension splices shall be designed to produce splice strength in tension or compression of not less than 125 percent of the ASTM-specified minimum yield strength of the rebar.

2. Compression type mechanical splices shall provide concentric bearing from one bar to the other and shall be capable of developing the ultimate strength of the rebar in compression.

I. Fibrous Reinforcement – The fibers shall be 100 percent virgin homopolymer polypropylene fibrillated fibers, containing no reprocessed olefin materials, manufactured in accordance with applicable building codes and ASTM C1116 Type III. Fibrous concrete reinforcement shall be Fibermesh 300, as manufactured by Propex Concrete Systems Corporation, Chattanooga, TN; or approved equal.

1. Acceptable polypropylene fibers shall possess the following characteristics:

a. Specific Gravity: 0.91

b. Tensile Strength: 80–110 ksi (kips per square inch)

c. Fiber Length: Graded per manufacturer.

2.3 FABRICATION

A. Fabrication of reinforcement shall be in compliance with the CRSI Manual of Standard Practice.

B. Bars shall be cold bent. Bars shall not be straightened or re-bent.

C. Bars shall be bent around a revolving collar having a diameter of not less than that recommended by ACI 318.

D. Bar ends that are to be butt-spliced, placed through limited diameter holes in metal, or threaded shall have the applicable end(s) saw-cut. Such ends shall terminate in flat surfaces within 1.5 degrees of a right angle to the axis of the bar.

E. Spirals:

1. Provide a minimum of one and one-half finishing turns at top and bottom, unless otherwise noted.

2. Splices shall be tension lap splices at least 48 bar diameters, but not less than 12 inches in length. Welded splices shall only be used where specifically approved by the Engineer.

3. Provide spacers as recommended by CRSI.

F. Schnell IDEA Machine – CONTRACTOR may fabricate rebar cage for beams using the Schnell IDEA Machine, with the following provisions:

1. Fabrication of pre-assembled steel cages shall be in the shop of a fabricator licensed to use Schnell IDEA Machine and with an in-house quality assurance program.

2. Shipping of pre-assembled steel cages to the project site will include a copy of the rebar certification from the mill and a copy of the welding test report from an approved third party test lab, engaged by and at the expense of the CONTRACTOR. The welding test is for the purpose of providing assurances that the rebar was not damaged during the welding operations.

3. Rebar to be welded shall comply with ASTM A706, Grade 60.

PART 3 EXECUTION

3.1 INSTALLATION

A. Surface condition, bending, spacing, and tolerances of placement of reinforcement shall comply with CRSI Manual of Standard Practice. The CONTRACTOR shall be solely responsible for providing an adequate number of bars and maintaining the spacing and clearances shown on the Drawings.

B. Except as otherwise noted on the Drawings, the minimum concrete cover for reinforcement shall be as follows:

1. Concrete cast against and permanently exposed to earth - 3 inches

2. Concrete exposed to soil, water, sewage, sludge, and/or weather (including bottom cover of slabs over water or sewage) - 2 inches

3. Concrete not exposed to soil, water, sewage, sludge, and/or weather:

a. Slabs (top and bottom cover), walls, joists, shells and folded plate members - 1.5 inches

b. Beams and columns, primary reinforcement - 2 inches

c. Ties, spirals, and stirrups - 1.5 inches

C. Reinforcement that will be exposed for a considerable length of time after being placed shall be coated with a heavy coat of neat cement slurry.

D. No reinforcing steel bars shall be welded either during fabrication or erection unless specifically shown on the Drawings or specified herein, or unless prior written approval has been obtained from the ENGINEER. All bars that have been welded, including tack welds, without such approval shall be immediately removed from the work. If welding of reinforcement is approved or specifically called for, it shall comply with AWS D1.4.

E. Reinforcing steel interfering with the location of other reinforcing steel, conduits, or embedded items may be moved within the specified tolerances or one bar diameter, whichever is greater. Greater displacements of bars to avoid interference shall only be made with the approval of the ENGINEER. Do not cut reinforcement to install inserts, conduits, mechanical openings, or other items without the prior approval of the ENGINEER.

F. Securely support and tie reinforcing steel to prevent movement during concrete placement. Secure dowels in place before placing concrete.

G. Reinforcing steel bars shall not be field bent except where shown on the Drawings or specifically authorized in writing by the ENGINEER. If authorized, bars shall be cold-bent around a standard diameter spool as specified within CRSI. Do not heat bars. Closely inspect the reinforcing steel for breaks. If the reinforcing steel is damaged, replace, Cadweld, or otherwise repair as directed by the ENGINEER. Do not bend reinforcement after it is embedded in concrete unless specifically permitted on the Drawings.

3.2 REINFORCEMENT AROUND OPENINGS

A. Unless specific additional reinforcement around openings is shown on the Drawings, provide additional reinforcing steel on each side of the opening equivalent to one-half of the cross-sectional area of the reinforcing steel interrupted by the opening. The bars shall have sufficient length to develop bond at each end beyond the opening or penetration.

3.3 SPLICING OF REINFORCEMENT

A. Splices designated as compression splices on the Drawings shall be 30 bar diameters, but not less than 12 inches, unless otherwise noted.

B. Tension lap splices shall be provided at all laps in compliance with ACI 318. The length of splices shall conform to the Contract Drawings. Splices in adjacent bars shall be staggered. Class A splices may be used when 50 percent or less of the bars are spliced within the required lap length. Class B splices shall be used at all other locations.

C. Except as otherwise indicated on the Drawings, splices in circumferential reinforcement in circular walls shall be Class B tension splices and shall be staggered. Adjacent bars shall not be spliced within the required lap length.

D. Install wire fabric in as long lengths as practicable. Splices in welded wire fabric shall be lapped in accordance with the requirements of ACI 318 but not less than 12 inches. The spliced fabrics shall be tied together with wire ties spaced not more than 24 inches on-center and laced with wire of the same diameter as the welded wire fabric. Do not position laps midway between supporting beams, or directly over beams of continuous structures. Offset splices in adjacent widths to prevent continuous splices.

E. Mechanical reinforcing steel splicers shall be used only where shown on the Drawings. Splices in adjacent bars shall be offset by at least 30 bar diameters, but not less than 24 inches. Mechanical reinforcing splices are only to be used for special splice and dowel conditions approved by the ENGINEER.

3.4 ACCESSORIES

A. Determine, provide, and install accessories such as chairs, chair-bars, and the like in sufficient quantities and strength to adequately support the reinforcement and prevent its displacement during the erection of the reinforcement and the placement of concrete.

B. Use precast concrete blocks (dobies) where the reinforcing steel is to be supported over soil. In no case shall such supports be continuous.

C. Stainless steel bar supports or steel chairs with stainless steel tips shall be used where the chairs are set on forms for a concrete surface that will be exposed to weather, high humidity, or liquid (including bottom of slabs over liquid-containing areas). Use of galvanized or plastic-tipped metal chairs is permissible in all other locations unless otherwise noted on the Drawings or specified herein.

D. Alternate methods of supporting top steel in slabs, such as steel channels supported on the bottom steel or vertical reinforcing steel fasteners to the bottom and top mats may be used if approved by the ENGINEER.

3.5 INSPECTION

A. In no case shall any reinforcing steel be covered with concrete until the installation of the reinforcement, including the size, spacing, and position of the reinforcement, has been observed by the ENGINEER and the ENGINEER's release to proceed with the concreting has been obtained. The ENGINEER shall be given a minimum of 24 hours prior notice of the readiness of placed reinforcement for observation. The forms shall be kept open until the ENGINEER has completed observations of the reinforcing steel.

END OF SECTION

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SECTION 03300 – CAST-IN-PLACE CONCRETE

PART 1 GENERAL

1.1 THE REQUIREMENT

A. Furnish all labor and materials required and install all cast-in-place concrete complete as shown on the Drawings and as specified herein.

1.2 REFERENCE SPECIFICATIONS, CODES, AND STANDARDS

A. American Concrete Institute (ACI)

1. ACI 304R – Guide for Measuring, Mixing, Transporting, and Placing Concrete
2. ACI 305 – Guide to Hot Weather Concreting
3. ACI 306 – Guide to Cold Weather Concreting
4. ACI 315 – Details and Detailing of Concrete Reinforcement
5. ACI 318 – Building Code Requirements for Structural Concrete

B. ASTM International (ASTM)

1. ASTM C31 – Standard Practice for Making and Curing Concrete Test Specimens in the Field
2. ASTM C33 – Standard Specification for Concrete Aggregates
3. ASTM C39 – Standard Test Method for Compressive Strength of Cylindrical Concrete Specimens
4. ASTM C42 – Standard Test Method for Obtaining and Testing Drilled Cores and Sawed Beams of Concrete
5. ASTM C94 – Standard Specification for Ready-Mixed Concrete
6. ASTM C143 – Standard Test Method for Slump of Hydraulic Cement Concrete
7. ASTM C150 – Standard Specification for Portland Cement
8. ASTM C157 – Standard Test Method for Length Change of Hardened Hydraulic Cement Mortar and Concrete
9. ASTM C171 – Standard Specification for Sheet Materials for Curing Concrete
10. ASTM C173 – Standard Test Method for Air Content of Freshly Mixed Concrete by the Volumetric Method
11. ASTM C231 – Standard Test Method for Air Content of Freshly Mixed Concrete by the Pressure Method

12. ASTM C260 – Standard Specification for Air-Entraining Admixtures for Concrete

13. ASTM C309 – Standard Specification for Liquid Membrane-Forming Compounds for Curing Concrete

14. ASTM C311 – Standard Test Methods for Sampling and Testing Fly Ash or Natural Pozzolans for Use in Portland-Cement Concrete

15. ASTM C494 – Standard Specification for Chemical Admixtures for Concrete

16. ASTM C596 – Standard Test Method for Drying Shrinkage of Mortar Containing Hydraulic Cement

17. ASTM C618 – Standard Specification for Coal Fly Ash and Raw or Calcined Natural Pozzolan for use in Concrete

18. ASTM C1017 – Standard Specification for Chemical Admixtures for use in Producing Flowing Concrete

19. ASTM C1602 – Standard Specification for Mixing Water Used in the Production of Hydraulic Cement Concrete

C. Where reference is made to one of the above standards, the revision in effect at the time of bid opening shall apply.

1.3 CONTRACTOR SUBMITTALS

A. Submit to the ENGINEER, in accordance with Division 1, submittals including the following:

1. Sources of cement, pozzolan, and aggregates.

2. Safety Data Sheets (SDS) for all concrete components and admixtures.

3. Air-entraining admixture – Product data including catalogue cut, technical data, storage requirements, product life, recommended dosage, temperature considerations, and conformity to ASTM standards.

4. Water-reducing admixture – Product data including catalogue cut, technical data, storage requirements, product life, recommended dosage, temperature considerations, and conformity to ASTM standards.

5. High range, water-reducing admixture – Product data including catalogue cut, technical data, storage requirements, product life, recommended dosage, temperature considerations, retarding effect, slump range, and conformity to ASTM standards. Identify proposed locations for use.

6. Concrete mix design for each formulation of concrete proposed for use including constituent quantities per cubic yard, water-cementitious materials ratio, type, and manufacturer of cement, compressive strength, concrete slump, shrinkage, and air content. Provide with (a) or (b) below for each mix proposed.

a. Standard deviation data for each proposed concrete mix based on statistical records, OR

b. The curve of water-cementitious materials ratio versus concrete cylinder strength for each formulation of concrete proposed based on laboratory tests. The cylinder strength shall be the average of the 28-day cylinder strength test results for each mix. Provide results of 7- and 14-day tests if available.

7. Sheet curing material – Product data including catalogue cut, technical data, and conformity to ASTM standards.

8. Liquid curing compound – Product data including catalogue cut, technical data, storage requirements, product life, application rate, and conformity to ASTM standards. Identify proposed locations of use.

9. Samples – Fine and coarse aggregates if requested by the ENGNEER.

10. Test Reports – Submit test reports for each of the following items:

    a. Fine aggregates – Sieve analysis, physical properties, and deleterious substances

    b. Coarse aggregates – Sieve analysis, physical properties, and deleterious substances

    c. Cements – Chemical analysis and physical properties for each type

    d. Pozzolans – Chemical analysis and physical properties

    e. Non-potable and/or water from concrete production operations.

11. Certifications:

    a. Certify that admixtures used in the same concrete mix are compatible with each other and the aggregates.

12. Shrinkage test reports

13. Work Plans:

    a. Hot weather concreting

    b. Cold weather concreting

1.4 QUALITY ASSURANCE

A. Reinforced concrete shall comply with ACI 318, and other stated requirements, codes, and standards. The most stringent requirement of the codes, standards, and this Section shall apply when conflicts arise.

B. Only one source of cement and aggregate shall be used on any one structure. Concrete shall be uniform in color and appearance.

C. Well in advance of placing concrete, discuss with the ENGINEER the sources of individual materials and batched concrete proposed for use. Discuss placement methods, waterstops, and curing. Propose methods of hot and cold weather concreting as required.

D. A meeting shall be held before placement of plasticized concrete. The plasticizer (high-range water-reducer) manufacturer's representative and the Contractor shall be available to discuss the properties and techniques of batching and placing plasticized concrete.

E. If, during the progress of the work, it is impossible to secure concrete of the required workability and strength with the materials being furnished, the ENGINEER may order such changes in proportions or materials, or both, as may be necessary to secure the desired properties. All changes so ordered shall be made at the CONTRACTOR's expense.

F. If, during the progress of work, the materials from the sources originally accepted change in characteristics, the CONTRACTOR shall, at their expense, make new acceptance tests of aggregates and establish new design mixes.

G. Testing of the following materials shall be furnished by the CONTRACTOR to verify conformity with this Specification Section and the stated ASTM Standard(s).

1. Fine aggregates for conformity to ASTM C33 – sieve analysis, physical properties, and deleterious substances

2. Coarse aggregates for conformity to ASTM C33 – sieve analysis, physical properties, and deleterious substances

3. Cements for conformity to ASTM C150 – chemical analysis and physical properties

4. Pozzolans for conformity to ASTM C618 – chemical analysis and physical properties

5. Non-potable and/or water from concrete production operations (ASTM C1602)

6. Proposed concrete mix design(s) – compressive strength, slump, shrinkage, and air content.

H. The CITY will provide field-testing and inspection services. The cost of such work, except as specifically stated otherwise, shall be paid by the CITY. Testing of the following items shall be by the CITY to verify conformity with this Specification Section.

1. Concrete placement – compressive strength (cylinders), compressive strength (cores), slump, and air content

2. Other materials or products that may come under question

I. All materials incorporated in the work shall conform to accepted samples.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Cement – Store cement in weathertight buildings, bins, or silos to provide protection from dampness and contamination and to minimize warehouse set.

B. Aggregate – Arrange and use stockpiles to avoid excessive segregation or contamination with other materials or with other sizes of like aggregates. Build stockpiles in successive horizontal layers not exceeding 3 feet in thickness. Complete each layer before the next is started. Do not use frozen or partially frozen aggregate.

C. Sand – Arrange and use stockpiles to avoid contamination. Allow sand to drain to uniform moisture content before using. Do not use frozen or partially frozen sands.

D. Admixtures – Store in closed containers to avoid contamination, evaporation, or damage. Provide suitable agitating equipment to assure uniform dispersion of ingredients in admixture solutions that tend to separate. Protect liquid admixtures from freezing and other temperature changes that could adversely affect their characteristics.

E. Pozzolan – Store in weathertight buildings, bins, or silos to provide protection from dampness and contamination.

F. Sheet Curing Materials – Store in weathertight buildings or off the ground and under cover.

G. Liquid curing compounds – Store in closed containers.

PART 2 PRODUCTS

2.1 GENERAL

A. The use of a manufacturer's name and model or catalog number is for the purpose of establishing the standard of quality and general configuration desired.

B. Like items of materials shall be the end products of one manufacturer in order to provide standardization for appearance, maintenance, and manufacturer's services.

2.2 MATERIALS

A. Materials shall comply with this Section and any applicable state or local requirements.

B. Cement – Domestic Portland cement shall comply with ASTM C150 Type I or II. Air-entraining cement shall not be used. The cement brand shall be subject to approval by the ENGINEER and one brand shall be used throughout the work.

C. Fine Aggregates – Fine aggregates shall be washed inert natural sand conforming to the requirements of ASTM C33.

D. Coarse Aggregates – Coarse aggregates shall be well-graded crushed stone or washed gravel conforming to the requirements of ASTM C33. Grading requirements shall be as listed in ASTM C33 Table 2 for the specified coarse aggregate size number. Limits of deleterious substances and physical property requirements shall be as listed in ASTM C33 Table 3 for severe weathering regions. Size numbers for concrete mixes shall be as shown in Table 1 herein.

E. Water – Water shall be potable and free from injurious amounts of oil, acids, alkalis, salts, organic matter, or other deleterious substances. Use of non-potable (recycled) and/or reclaimed (from concrete production operations) water is acceptable with the following provisions:

1. Use of recycled or reclaimed water in concrete for liquid containing structures is not permissible.

2. Recycled and/or reclaimed water shall be tested in accordance with ASTM C1602, Tables 1 and 2. Testing by an independent testing laboratory engaged at the expense of the Contractor, shall occur before first use and thereafter every month. Concrete and not mortar batches shall be tested.

3. Density of reclaimed water will be tested on a daily basis. Use of reclaimed water with densities in excess of 1.03 is not permissible.

F. Admixtures – Admixtures shall be free of chlorides and alkalis (except for those attributable to water). When it is required to use more than one admixture in a concrete mix, the admixtures shall be from the same manufacturer. Admixtures shall be compatible with the concrete mix including other admixtures.

1. Air-Entraining Admixture – The admixture shall comply with ASTM C260. Proportioning and mixing shall be in accordance with manufacturer's recommendations.

2. Admixtures causing retarded or accelerated setting of concrete shall not be used without written approval from the ENGINEER. When allowed, the admixtures shall be retarding or accelerating water-reducing or high-range water-reducing admixtures.

3. Water-Reducing Admixture – The admixture shall comply with ASTM C494, Type A. Proportioning and mixing shall be in accordance with manufacturer's recommendations.

4. High-Range Water-Reducer (Plasticizer) – The admixture shall comply with ASTM C494, Type F and shall result in nonsegregating plasticized concrete with little bleeding and with the physical properties of low water/cement ratio concrete. The treated concrete shall be capable of maintaining its plastic state in excess of 2 hours. Proportioning and mixing shall be in accordance with manufacturer's recommendations.

G. Pozzolan (Fly Ash) – Pozzolan shall be Class F fly ash complying with ASTM C618, except the Loss On Ignition (LOI) shall be limited to 3 percent maximum.

H. Sheet Curing Material – Sheet curing material shall be waterproof paper, polyethylene film, or white burlap-polyethylene sheeting, all of which must comply with ASTM C171.

I. Liquid Curing Compound – Liquid membrane-forming curing compound shall comply with the requirements of ASTM C309, Type 1-D (clear or translucent with fugitive dye) and shall contain no wax, paraffin, or oil.

2.3 CONCRETE MIXES

A. Development of mix designs and testing shall be by an independent testing laboratory acceptable to the ENGINEER but engaged by and at the expense of the CONTRACTOR.

B. Select proportions of ingredients to meet the design strength and materials limits specified in Table 1 and to produce concrete having proper placability, durability, strength, appearance, and other required properties. Proportion ingredients to produce a homogenous mixture that will readily work into corners and angles of forms and around reinforcement without permitting materials to segregate or allowing excessive free water to collect on the surface.

C. The design mix shall be based on standard deviation data of prior mixes with essentially the same proportions of the same constituents or, if such data is not available, be developed by a testing laboratory, acceptable to the ENGINEER, engaged by and at the expense of the CONTRACTOR. Acceptance of mixes based on standard deviation shall be based on the modification factors for standard deviation tests contained in ACI 318. The water content of the concrete mix, determined by laboratory testing, shall be based on a curve showing the relation between the water-cementitious ratio and 7- and 28-day compressive strengths of concrete made using the proposed materials. The curves shall be determined by four or more points, each representing an average value of at least three test specimens at each age. The curves shall have a range of values sufficient to yield the desired data, including the specified design strengths as modified below, without extrapolation. The water content of the concrete mixes to be used, as determined from the curve, shall correspond to strengths 16 percent greater than the specified design strengths. The resulting mix shall not conflict with the limiting values for maximum water-cementitious ratio and net minimum cementitious content as specified in Table 1.

D. Compression Tests – Provide testing of the proposed concrete mix or mixes to demonstrate compliance with the specified design strength requirements in conformity with the above paragraph.

E. Shrinkage Tests – Perform shrinkage tests for Class D concrete. The tests shall conform to ASTM C157 as modified by ASTM C596. Concrete and not mortar specimens shall be used.

   1. The average shrinkage at 25 days of air storage shall not exceed 0.036 percent.

F. Air content (entrapped + entrained), as measured by ASTM C231, shall be as shown in Table 1. Air Entrainment range shall be between 3.5% to 5%.

   1. If the air-entraining agent proposed for use in the mix requires testing methods other than ASTM C231 to accurately determine air content, make special note of this requirement in the admixture submittal.

G. Slump of the concrete as measured by ASTM C143, shall be as shown in Table 1. If a high-range water-reducer (plasticizer) is used, the slump indicated shall be that measured before plasticizer is added. Plasticized concrete shall have a slump ranging from 7 to 10 inches.

H. Proportion admixtures according to the manufacturer's recommendations. Two or more admixtures specified may be used in the same mix provided that the admixtures in combination retain full efficiency and have no deleterious effect on the concrete or on the properties of each other.

Table 1
Concrete Mix Requirements

Class	Design Strength (1)	Cement (2)	Fine Aggregate (2)	Coarse Aggregate (3)	Cementitious Content lbs./cu. yd. (min) (4)
A	2500	C150 Type II	C33	57	440
B	3000	C150 Type II	C33	57	480
D	4500	C150 Type II	C33	57	560

Class	W/C Ratio (Max.) (5)	Fly Ash (6)	AC Range (7)	WR (8)	HRWR (9)	Slump Range Inches
A	0.62	--	5 to 6.5	Yes	No	1–4
B	0.54	--	5 to 6.5	Yes	No	1–3
D	0.42	15–25%	5 to 6.5	Yes	No	3–5

NOTES:
(1) Minimum compressive strength in pounds per square inch at 28 days
(2) ASTM designation
(3) Size Number in ASTM C33
(4) Cementitious content in pounds per cubic yard
(5) W/C is water-cementitious ratio by weight
(6) Percent content of total cementitious material
(7) AC is percent air content (entrapped + entrained). Air Entrainment range 3.5% to 5%.
(8) WR is water-reducer admixture
(9) HRWR is high-range water-reducer admixture

PART 3 EXECUTION

3.1 MEASURING MATERIALS

A. Concrete shall be composed of Portland cement, fine aggregate, coarse aggregate, water, and admixtures as specified and shall be produced by a plant acceptable to the ENGINEER. All constituents, including admixtures, shall be batched at the plant except a high-range water-reducer may be added in the field.

B. Measure materials for batching concrete by weighing in conformity with and within the tolerances given in ASTM C94 except as otherwise specified. Scales shall have been certified by the local Sealer of Weights and Measures within one year of use.

C. Measure the amount of free water in fine aggregates within 0.3 percent with a moisture meter. Compensate for varying moisture contents of fine aggregates. Record the number of gallons of water as batched on printed batching tickets.

D. Admixtures shall be dispensed either manually using calibrated containers or measuring tanks, or by means of an automatic dispenser approved by the manufacturer of the specific admixture.

1. Charge air-entraining and chemical admixtures into the mixer as a solution using an automatic dispenser or similar metering device.

2. Inject multiple admixtures separately during the batching sequence.

3.2 MIXING AND TRANSPORTATION

A. Concrete shall be ready-mixed concrete. No hand mixing will be permitted. Clean each transit mix truck drum and reverse drum rotation before the truck proceeds under the batching plant. Equip each transit-mix truck with a continuous, nonreversible, revolution counter showing the number of revolutions at mixing speeds.

B. Ready-mix concrete shall be transported to the site in watertight agitator or mixer trucks loaded not in excess of their rated capacities as stated on the nameplate.

C. Keep the water tank valve on each transit truck locked at all times. Any addition of water must be approved by the ENGINEER. Added water shall be incorporated by additional mixing of at least 35 revolutions. All added water shall be metered and the amount of water added shall be shown on each delivery ticket. Addition of water is not permissible if the:

1. Maximum slump value listed will be exceeded.

2. Maximum water-cementitious ratio will be exceeded.

3. More than1/4-cubic yard of concrete has been discarded from mixer/truck.

D. All central plant and rolling stock equipment and methods shall comply with ACI 318 and ASTM C94.

E. Select equipment of size and design to ensure continuous flow of concrete at the delivery end. Metal or metal-lined non-aluminum discharge chutes shall be used and shall have slopes not exceeding 1 vertical to 2 horizontal and not less than 1 vertical to 3 horizontal. Chutes more than 20 feet long and chutes not meeting slope requirements may be used if concrete is discharged into a hopper before distribution.

F. Retempering (mixing with or without additional cement, aggregate, or water) of concrete or mortar that has reached initial set will not be permitted.

G. Handle concrete from mixer to placement as quickly as practicable while providing concrete of required quality in the placement area. Dispatch trucks from the batching plant so they arrive at the work site just before the concrete is required, thus avoiding excessive mixing of concrete while waiting, or delays in placing successive layers of concrete in the forms.

H. Furnish a delivery ticket for ready-mixed concrete to the ENGINEER as each truck arrives. Each ticket shall provide a printed record of the weight of cement and each aggregate as batched individually. Use the type of indicator that returns for zero punch or returns to zero after a batch is discharged. Clearly indicate the weight of fine and coarse aggregate, cement, and water in each batch, the quantity delivered, the time any water is added, and the numerical sequence of the delivery. Show the time of day batched and time of discharge from the truck. Indicate the number of revolutions of the truck mixer.

3.3 TEMPERATURE AND MIXING TIME CONTROL

A. In cold weather, do not allow the as-mixed temperature of the concrete and concrete temperatures at the time of placement in the forms to drop below 40 degrees Fahrenheit (F).

B. If water or aggregate has been heated, combine water with aggregate in the mixer before cement is added. Do not add cement to mixtures of water and aggregate when the temperature of the mixture is greater than 90 degrees F.

C. In hot weather, cool ingredients before mixing to maintain temperature of the concrete below the maximum placing temperature of 90 degrees F. If necessary, substitute well-crushed ice for all or part of the mixing water.

D. The maximum time interval between the addition of mixing water and/or cement to the batch and the placing of concrete in the forms shall not exceed the values shown in Table 2.

E. If an approved high-range water-reducer (plasticizer) is used to produce plasticized concrete, the maximum time interval shall not exceed 90 minutes.

Table 2
Maximum Time to Discharge of Concrete

Air or Concrete Temperature (Whichever is higher)	Maximum Time (Minutes)
70 to 90 Degrees F (21 to 32 Degrees C)	60
40 to 69 Degrees F (5 to 20 Degrees C)	90

F = Fahrenheit, C = Celsius

3.4 CONCRETE APPEARANCE

A. Concrete mix showing either poor cohesion or poor coating of the coarse aggregate with paste shall be remixed. If this does not correct the condition, the concrete shall be rejected. If the slump is within the allowable limit, but excessive bleeding, poor workability, or poor finishability are observed, changes in the concrete mix shall be obtained only by adjusting one or more of the following:

1. The gradation of the aggregate

2. The proportion of fine and coarse aggregate

3. The percentage of entrained air, within the allowable limits

B. Concrete for the work shall provide a homogeneous structure that, when hardened, will have the required strength, durability, and appearance. Mixtures and workmanship shall be such that concrete surfaces, when exposed, will require no finishing. When concrete surfaces are stripped, the concrete, when viewed in good lighting from 10 feet away, shall be pleasing in appearance, and at 20 feet shall show no visible defects.

3.5 PLACING AND COMPACTING

A. Placing:

1. Placing of all concrete shall be in accordance with the recommendations contained in ACI 304R.

2. Verify that all formwork completely encloses concrete to be placed and is securely braced before concrete placement. Remove ice, excess water, dirt, and other foreign materials from forms. Confirm that reinforcement and other embedded items are securely in place. Have a competent worker at the location of the placement that can assure that reinforcing steel and embedded items remain in designated locations while concrete is being placed. Sprinkle semi-porous sub grades or forms to eliminate suction of water from the mix. Seal extremely porous sub grades in an approved manner.

3. Deposit concrete as near to its final position as possible to avoid segregation due to rehandling or flowing. Place concrete continuously at a rate that ensures the concrete is being integrated with fresh plastic concrete. Do not deposit concrete that has partially hardened or has been contaminated by foreign materials or on concrete that has hardened sufficiently to cause formation of seams or planes of weakness within the section. If the section cannot be placed continuously, place construction joints as specified or as approved.

4. Pumping of concrete will be permitted. Use a mix design and aggregate sizes suitable for pumping and submit for approval.

5. Remove temporary spreaders from forms when the spreader is no longer useful. Temporary spreaders may remain embedded in concrete only when made of galvanized metal or concrete and if prior approval has been obtained.

6. Do not place concrete for supported elements until concrete previously placed in the supporting element (columns, slabs, and/or walls) has reached adequate strength.

B. Slabs:

1. After suitable bulkheads, screeds, and jointing materials have been positioned, the concrete shall be placed continuously between construction joints beginning at a bulkhead, edge form, or corner. Each batch shall be placed into the edge of the previously placed concrete to avoid stone pockets and segregation.

2. Avoid delays in casting. If there is a delay in casting, the concrete placed after the delay shall be thoroughly spaded and consolidated at the edge of that previously placed to avoid cold joints. Concrete shall then be brought to correct level and struck off with a straightedge. Bullfloats or darbies shall be used to smooth the surface, leaving it free of humps or hollows.

3. "Jitterbugs" shall not be used on slab surfaces to aid in finishing.

C. Formed Concrete:

1. Place concrete in forms using tremie tubes and taking care to prevent segregation. Bottom of tremie tubes shall preferably be in contact with the concrete already placed. Do not permit concrete to drop freely more than 4 feet. Place concrete for walls in 12- to 24-inch lifts, keeping the surface horizontal. If plasticized concrete is used, the maximum lift thickness may be increased to 7 feet and the maximum free fall of concrete shall not exceed 15 feet.

D. Compacting:

1. Consolidate concrete by vibration, puddling, spading, rodding, or forking so that concrete is thoroughly worked around reinforcement, embedded items, and openings, and into corners of forms. Puddling, spading, etc. shall be continuously performed along with vibration of the placement to eliminate air or stone pockets that may cause honeycombing, pitting, or planes of weakness.

2. All concrete shall be placed and compacted with mechanical vibrators. The number, type, and size of the units shall be approved by the ENGINEER in advance of placing operations. No concrete shall be ordered until sufficient approved vibrators (including standby units in working order) are on the job site.

3. A minimum frequency of 7,000 revolutions per minute is required for mechanical vibrators. Insert and withdraw vibrators vertically at points from 18 to 30 inches apart. At each insertion, vibrate sufficiently to consolidate concrete, generally from 5 to 15 seconds. Do not over-vibrate so as to segregate. Keep a spare vibrator on the site during concrete placing operations.

4. Concrete Slabs – Concrete for slabs less than 8 inches thick shall be consolidated with vibrating screeds; slabs 8 to 12 inches thick shall be compacted with internal vibrators and (optionally) with vibrating screeds. Vibrators shall always be placed into concrete vertically and shall not be laid horizontally or laid over.

5. Walls – Internal vibrators (rather than form vibrators) shall be used unless otherwise approved by the ENGINEER. In general, for each vibrator needed to melt down the batch at the point of discharge, one or more additional vibrators must be used to densify, homogenize, and perfect the surface. The vibrators shall be inserted vertically at regular intervals, through the fresh concrete and slightly into the previous lift, if any.

6. Amount of Vibration – Vibrators are to be used to consolidate properly placed concrete but shall not be used to move or transport concrete in the forms. Vibration shall continue until the following conditions are met:

   a. The frequency returns to normal.

   b. The surface appears liquefied, flattened, and glistening.

   c. Trapped air ceases to rise.

   d. Coarse aggregate has blended into the surface, but has not disappeared.

3.6 CURING AND PROTECTION

A. Protect all concrete work against injury from the elements and defacements of any nature during construction operations.

B. Curing Methods:

1. Curing Methods for Concrete Surfaces – Cure concrete to retain moisture and maintain specified temperature at the surface for a minimum of 7 days after placement. Curing methods to be used are as follows:

   a. Water Curing – Keep entire concrete surface wet by ponding, continuous sprinkling, or covering with saturated burlap. Begin wet cure as soon as concrete attains an initial set and maintain wet cure 24 hours a day.

   b. Sheet Material Curing – Cover entire surface with sheet material. Securely anchor sheeting to prevent wind and air from lifting the sheeting or entrapping air under the sheet. Place and secure sheet as soon as initial concrete set occurs.

   c. Liquid Membrane Curing – Apply curing compound over the entire concrete surface except for surfaces to receive additional concrete. Curing compound shall NOT be placed on any concrete surface where additional concrete is to be placed, where concrete sealers or surface coatings are to be used, or where the concrete finish requires an integral floor product. Curing compound shall be applied as soon as the free water on the surface has disappeared and no water sheen is visible, but not after the concrete is dry or when the curing compound can be absorbed into the concrete. Application shall be in compliance with the manufacturer's recommendations.

C. Specified Applications of Curing Methods:

1. Slabs for Water Containment Structures – Use water curing only.

2. Slabs on Grade and Footings (not used to contain water) – Water curing, sheet material curing, or liquid membrane curing shall be used.

3. Structural Slabs (other than water containment) – Water curing or liquid membrane curing shall be used.

4. Horizontal Surfaces that will Receive Additional Concrete, Coatings, Grout or Other Material that Requires Bond to the substrate – Water curing shall be used.

5. Formed Surfaces – No curing shall be used if nonabsorbent forms are left in place 7 days. Water curing shall be used if absorbent forms are used. Sheet curing or liquid membrane curing shall be used if forms are removed before 7 days. Exposed horizontal surfaces of formed walls [or columns] shall be water cured for 7 days or until next placement of concrete is made.

6. Concrete Joints – Water curing or sheet material curing shall be used.

D. Finished surfaces and slabs shall be protected from the direct rays of the sun to prevent checking and crazing.

3.7 REMOVAL OF FORMS

A. Except as otherwise specifically approved by the ENGINEER, forms shall not be removed before the concrete has attained a strength of at least 30 percent of its specified design strength, nor before reaching 100 degree days of curing for walls and vertical surfaces (including but not limited to exposed surfaces of slab-on-grade), and 500 degree days of curing for beams and slabs, (whichever is the longer). Degree days are defined as the total number of 24-hour periods multiplied by the weighted average daily air temperature at the surface of the concrete (e.g., 5 days at an average 70 degrees F = 350 degree days).

B. Shores shall not be removed until the concrete has attained at least 60 percent of its specified design strength and also sufficient strength to support safely its own weight and construction live loads.

3.8 INSPECTION AND FIELD TESTING

A. The batching, mixing, transporting, placing, and curing of concrete shall be subject to the inspection of the ENGINEER at all times. The CONTRACTOR shall advise the ENGINEER of their readiness to proceed at least 24 hours before each concrete placement. The ENGINEER will inspect the preparations for concreting including the preparation of previously placed concrete, the reinforcing steel and the alignment, and the cleanliness and tightness of formwork. No placement shall be made without the inspection and acceptance of the ENGINEER.

B. Sets of field control cylinder specimens will be taken by an independent entity paid for by the CONTRACTOR during the progress of the work, in compliance with ASTM C31. The number of sets of concrete test cylinders taken of each class of concrete placed each day shall not be less than one set per day, nor less than one set for each 150 cubic yards of concrete, nor less than one set for each 3,000 square feet of surface area for slabs or walls. If the total volume of concrete were such that the frequency of testing required for a given class of concrete would provide less than five strength tests, tests shall be made from at least five randomly selected batches or from each batch if fewer than five batches are anticipated.

C. A "set" of test cylinders consists of six cylinders: two to be tested at 7 days and two to be tested and their strengths averaged at 28 days. The final two may be used for a special test at 3 days or to verify strength after 28 days if 28-day test results are low. The CONTRACTOR shall provide a copy of all concrete test results to the CITY for review.

D. When the average 28-day compressive strength of the cylinders in any set falls below the specified design strength or below proportional minimum 7-day strengths (where the proper relationships between 7- and 28-day strengths have been established by tests), proportions, water content, or temperature conditions shall be changed to achieve the required strengths.

E. The CONTRACTOR shall cooperate in the making of tests by allowing free access to the work for the selection of samples; providing an insulated, closed curing box for specimens; affording protection to the specimens against injury or loss through the operations; and furnishing material and labor required for the purpose of taking concrete cylinder samples. All shipping of specimens will be paid for by the CONTRACTOR. Curing boxes shall be acceptable to the ENGINEER.

F. Concrete Slump:

1. Slump tests will be made in the field immediately before placing the concrete by an independent entity paid for by the CITY. Such tests shall be made in accordance with ASTM C143. If the slump is greater than the specified range, the concrete shall be rejected.

2. At a minimum the first three trucks shall be tested to establish consistency. Additionally, testing will be performed with each strength test (cylinders) and each air content test.

3. The ENGINEER reserves the right to increase the frequency of testing when deemed necessary.

G. Air Content:

1. Testing for air content shall be performed on a fresh concrete sample by an independent entity paid for by the CITY. Air content testing for concrete made of ordinary aggregates having low absorption shall be performed in compliance with either the pressure method complying with ASTM C231 or by the volumetric method complying with ASTM C173. If lightweight aggregates or aggregates with high absorptions are used, the latter test method shall be used. If air content is below the specified air-entrainment range listed in Table 1, air-entraining admixture may be added on-site to bring the concrete within specifications. If measured air content is above the specified air-entrainment range (+1.5%) listed, the concrete shall be rejected.

2. At a minimum, the first three trucks shall be tested to establish consistency, then every third truck thereafter. Additionally, an air content test shall be performed with each strength test (cylinders). Concrete samples for the testing of air content shall be taken at the point of placement and not at the truck chute/hopper.

3. The ENGINEER reserves the right to increase the frequency of testing when deemed necessary.

H. Shrinkage:

1. Field test specimens shall be handled and tested by the CITY as specified herein under “Concrete Mixes."

2. One set of three test specimens shall be made and tested from each placement of concrete for water containment structures.

3. The maximum concrete shrinkage for specimens cast in the field shall not exceed the trial batch maximum shrinkage requirement by more than 25 percent.

4. If the required shrinkage limitation is not met during construction, the CONTRACTOR shall take any or all of the following actions, at no additional cost to the CITY, to achieve the specified shrinkage requirements. These actions may include changing the source of aggregates, cement, and/or admixtures; reducing water content; washing of aggregate to reduce fines; increasing the number of construction joints; modifying the curing requirements; or other actions designed to minimize shrinkage or the effects of shrinkage.

I. The ENGINEER may have cores taken from any questionable area in the concrete work such as construction joints and other locations as required for determination of concrete quality. The results of tests on such cores shall be the basis for acceptance, rejection, or determining the continuation of concrete work.

J. The CONTRACTOR shall cooperate in obtaining cores by allowing free access to the work and permitting the use of ladders, scaffolding, and such incidental equipment as may be required. Repair all core holes. The work of cutting and testing the cores will be at the expense of the CITY.

3.9 FAILURE TO MEET REQUIREMENTS

A. Should the strengths shown by test specimens made and tested in compliance with the previous provisions fall below the values given in Table 1, the ENGINEER shall have the right to require changes in proportions outlined to apply to the remainder of the work. Furthermore, the ENGINEER shall have the right to require additional curing, for a duration determined by the ENGINEER, on those portions of the structure represented by the test specimens that failed. The cost of such additional curing shall be at the CONTRACTOR's expense. In the event that such additional curing does not give the strength required, as evidenced by core and/or load tests, the ENGINEER shall have the right to require strengthening or replacement of those portions of the structure that fail to develop the required strength. The cost of all such core borings and/or load tests, and any strengthening or concrete replacement required because strengths of test specimens are below that specified, shall be entirely at the expense of the CONTRACTOR. In such cases of failure to meet strength requirements, the CONTRACTOR and ENGINEER shall confer to determine what adjustment, if any, can be made in compliance with Sections titled "Strength" and "Failure to Meet Strength Requirements" of ASTM C94. The "purchaser" referred to in ASTM C94 is the CONTRACTOR in this Section.

B. When the tests on field control specimens of concrete fall below the specified strength, the ENGINEER will permit check tests for strengths to be made by means of typical cores drilled from the structure in compliance with ASTM C42 and C39. In the case of cores not indicating adequate strength, the ENGINEER, in addition to other recourses, may require, at the CONTRACTOR's expense, load tests on any one of the elements in which such concrete was used. Tests need not be made until concrete has aged 60 days.

C. Should the strength of test cylinders fall below 60 percent of the required minimum 28-day strength, the concrete shall be rejected and shall be removed and replaced.

3.10 PATCHING AND REPAIRING

A. It is the intent of this Section to require quality work including adequate forming, proper mixture and placement of concrete, and curing, so completed concrete surfaces will require no patching.

B. Defective concrete and honeycombed areas shall be repaired as directed by the ENGINEER.

C. As soon as forms have been removed and the concrete surfaces exposed, fins and other projections shall be removed. All exposed surfaces shall be carefully examined and any irregularities shall be immediately rubbed or ground in a satisfactory manner in order to secure a smooth, uniform, and continuous surface. Plastering or coating of surfaces to be smoothed will not be permitted. No repairs shall be made until after inspection by the ENGINEER. In no case will extensive patching of honeycombed concrete be permitted. Concrete containing minor voids, holes, honeycombing, or similar depression defects shall be repaired as specified herein. Concrete containing extensive voids, holes, honeycombing, or similar depression defects shall be completely removed and replaced. The CONTRACTOR, at their own expense, shall promptly execute all repairs and replacements herein specified.

D. Defective surfaces to be repaired as specified in Paragraph C shall be cut back from true line a minimum depth of 1/2 inch over the entire area. Feathered edges will not be permitted. Where chipping or cutting tools are not required in order to deepen the area properly, the surface shall be prepared for bonding by the removal of all laitance or soft material and not less than 1/32-inch depth of the surface film from all hard portions, by means of an efficient sandblast. After cutting and sandblasting, the surface shall be wetted sufficiently in advance of shooting with shotcrete or with cement mortar so that while the repair material is being applied, the surfaces under repair will remain moist, but not so wet as to overcome the suction upon which a good bond depends. The material used for the repair proposed shall contain such proportion of Atlas White Portland Cement as is required to make the color of the patch match the color of the surrounding concrete.

E. Recesses left by the removal of form ties shall be filled. Immediately after removal of forms, remove plugs and break off metal ties as required by Section 03100. Promptly fill holes upon stripping as follows: moisten the hole with water, followed by a 1/16-inch brush coat of neat cement slurry mixed to the consistency of a heavy paste. Immediately plug the hole with a 1 to 1.5 mixture of cement and concrete sand mixed slightly damp to the touch (just short of "balling"). Hammer the grout into the hole until dense and an excess of paste appears on the surface in the form of a spider web. Trowel smooth with heavy pressure. Avoid burnishing.

F. Surface defects that do not impair structural strength shall be repaired. When patching exposed surfaces the same source of cement and sand as used in the parent concrete shall be employed. Adjust color if necessary by addition of proper amounts of white cement. Rub lightly with fine Carborundum stone at an age of 1 to 5 days if necessary to bring the surface down to flush with the parent concrete. Exercise care to avoid damaging or staining the virgin skin of the surrounding parent concrete. Wash thoroughly to remove all rubbed matter.

G. Clean all exposed concrete surfaces and adjoining work stained by leakage of concrete.

3.11 SCHEDULE

A. Table 3 lists the general applications for the various concrete classes and design strengths.

Table 3
Concrete Schedule

Class	Design Compressive Strength at 28 days (psi)	Description
A	2,500	Concrete fill and duct encasement
B	3,000	Concrete overlay slabs and pavements
C	N/A	Not used
D	4,500	Walls, slabs on grade, suspended slab and beam systems, columns, grade beams, and all other structural concrete
E	5,000	Precast Concrete

END OF SECTION

SECTION 03305 – ELECTRICAL AND INSTRUMENTATION DUCT ENCASEMENT CONCRETE

PART 1 GENERAL

1.1 THE REQUIREMENT

A. Furnish all labor, materials, equipment, and incidentals required and place concrete encasement around underground electrical/instrumentation ductwork as shown on the Drawings and as specified herein.

PART 2 PRODUCTS

NOT USED

PART 3 EXECUTION

3.1 GENERAL

A. Concrete shall be measured, mixed and placed, and compacted as required in Section 03300 for Class A concrete and as specified below.

B. Add 8 pounds of red coloring pigment per cubic yard of concrete.

C. Provide not less than 3 inches of concrete between the outside of a duct and the earth. Provide not less than 3 inches of concrete between adjacent ducts.

D. All duct line concrete pours shall be continuous between manholes or handholes and between manholes or handholes and structures.

E. Where duct lines pass through concrete walls, concrete envelopes shall be extended through and finished flush with inside surfaces and finished as indicated on the Drawings. Construction joints as shown on the Drawings shall be provided.

F. All duct encasements shall be reinforced with concrete reinforcement complying with Section 03200.

G. Duct lines shall be laid in trenches on mats of Class 2 aggregate base not less than 6 inches thick and well graded.

H. The minimum top cover for duct banks shall be 24 inches.

END OF SECTION

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SECTION 03350 – CONCRETE FINISHING

PART 1 GENERAL

1.1 THE REQUIREMENT

A. Furnish all labor, materials, equipment and incidentals required to finish cast-in-place concrete surfaces as shown on the Drawings and as specified herein.

1.2 REFERENCE SPECIFICATIONS, CODES, AND STANDARDS

A. ASTM International (ASTM)

1. ASTM C33 – Standard Specification for Concrete Aggregates

2. ASTM C309 – Standard Specification for Liquid Membrane-Forming Compounds for Curing Concrete

3. ASTM C779 – Standard Test Method for Abrasion Resistance of Horizontal Concrete

B. Where reference is made to one of the above standards, the revision in effect at the time of bid opening shall apply.

1.3 CONTRACTOR SUBMITTALS

A. Submit to the ENGINEER, in accordance with Division 1, product data showing materials of construction and details of application for the following:

1. Concrete Sealer – Submit product data including catalogue cuts, technical data, storage requirements, product life, working time after mixing, temperature considerations, conformity to required ASTM standards, and Material Safety Data Sheet. Confirmation that the sealer is compatible with additionally applied coatings shall also be submitted.

2. Concrete Hardener – Submit product data including catalogue cuts, technical data, storage requirements, product life, application requirements, conformity to required ASTM standards, and Material Safety Data Sheet.

1.4 QUALITY ASSURANCE

A. Finish:

1. For concrete that will receive additional applied finishes or materials, the surface finish specified is required for the proper application of the specified manufacturer's products. Where alternate products are approved for use, determine if changes in finish are required and provide the proper finish to receive these products.

2. Changes in finish made to accommodate products different from those specified shall be performed at no additional cost to the CITY. Submit the proposed new finish and their construction methods to the ENGINEER for approval.

B. Services of Manufacturer's Representative:

1. The CONTRACTOR shall make available, at no additional cost to the CITY, upon 72 hours notification, the services of a qualified field representative of the manufacturer of the curing compound, sealer, or hardener to instruct the user on the proper application of the product under the prevailing job conditions.

PART 2 PRODUCTS

2.1 GENERAL

A. The use of a manufacturer's name and model or catalog number is for the purpose of establishing the standard of quality and general configuration desired.

2.2 MATERIALS

A. Concrete sealer shall comply with ASTM C309, Type 1, Class A or B. Concrete sealer must also be compliant with State of California VOC regulations. Concrete sealer shall be Spartan Cote WB II by Edoco (Burke), Kure-N-Seal WB by BASF Building Systems (Sonneborn), or equal.

B. Concrete Hardener must be compliant with State of California VOC regulations. Concrete hardener shall be MasterTop 100 by BASF Building Systems, Burke Nonmetallic Hardener by Edoco (Burke), or equal.

PART 3 EXECUTION

3.1 FORMED SURFACES

A. Forms shall not be removed before the requirements of Section 03300 have been satisfied.

B. Exercise care to prevent damaging edges or obliterating the lines of chamfers, rustications, or corners when removing the forms or performing any other work adjacent thereto.

C. Clean all exposed concrete surfaces and adjoining work stained by leakage of concrete.

D. Rough-Formed Surfaces:

1. Immediately after stripping forms and before concrete has changed color, carefully remove all fins and projections.

2. Promptly fill holes left by tie cones and defects as specified in Section 03300.

E. Rubbed Finish:

1. Immediately upon stripping forms and before concrete has changed color, carefully remove all fins. While the wall is still damp apply a thin coat of medium-consistency neat cement slurry by means of bristle brushes to provide a bonding coat within all pits, air holes, or blemishes in the parent concrete. Avoid coating large areas with slurry at one time.

2. Before slurry has dried or changed color, apply a dry (almost crumbly) grout proportioned by volume and consisting of 1 part cement to 1 1/2 parts of clean masonry sand having a fineness modulus of approximately 2.3 and complying with the gradation requirements of ASTM C33 for such a material. Grout shall be uniformly applied by means of damp pads of coarse burlap approximately 6 inches square used as a float. Scrub grout into the pits and air holes to provide dense mortar in all imperfections.

3. Allow the mortar to partially harden for 1 or 2 hours depending upon the weather and ambient temperature. If the air is hot and dry, keep the wall damp during this period using a fine fog spray. When the grout is hardened sufficiently so it can be scraped from the surface with the edge of a steel trowel without damaging the grout in the small pits or holes, cut off all that can be removed with a trowel. (Caution: Grout allowed to remain on the wall too long will harden and will be difficult to remove).

4. Allow the surface to dry thoroughly and rub it vigorously with clean, dry burlap to completely remove any dried grout. No visible film of grout shall remain after this rubbing. The entire cleaning operation for any area must be completed the day it is started. Do not leave grout on surfaces overnight. Allow sufficient time for grout to dry after it has been cut off with the trowel so it can be wiped off clean with the burlap.

5. On the day following the repair of pits, air holes, and blemishes, the walls shall again be wiped clean with dry, used pieces of burlap containing old, hardened mortar, which will act as a mild abrasive. After this treatment, there shall be no built-up film remaining in the parent surface. If, however, such a film is present, a fine abrasive stone shall be used to remove all such material without breaking through the surface film of the original concrete. Such scrubbing shall be light and sufficient only to remove excess material without changing the texture of the concrete.

6. A thorough wash-down with stiff bristle brushes shall follow the final bagging or stoning operations. No extraneous materials shall remain on the surface of the wall. The wall shall be sprayed with a fine fog spray periodically to maintain a continually damp condition for at least 3 days after application of the repair grout.

F. Abrasive Blast Finish:

1. Coordinate with Rubbed Finish application. Do not begin until Rubbed Finish operation is complete or before concrete has reached minimum 7-day strength. The Rubbed Finish application may be deleted by the ENGINEER if the unfinished concrete surface is of superior quality. Apply the abrasive blast finish only where indicated on Drawings.

2. Prepare a sample area of minimum 4 feet high by 16 feet wide and blast Finish as directed by ENGINEER on a portion of new wall construction that will not be exposed in the final work. The sample area shall contain a variety of finishes obtained with different nozzles, nozzle pressures, grit materials, and blasting techniques for selection by ENGINEER. The final accepted sample shall remain exposed until completion of all blast finish operations.

3. The blast finish operation shall meet all regulatory agency requirements. The blast finish CONTRACTOR shall be responsible for obtaining all required permits and/or licenses.

4. Perform abrasive blast finishing in as continuous an operation as possible, utilizing the same work crew to maintain continuity of finish on each surface or area of work. Maintain patterns or variances in depths of blast as present on the accepted sample.

5. Use an abrasive grit of proper type and gradation as well as equipment and technique to expose aggregate and surrounding matrix surfaces as follows:

   a. Medium: Generally expose coarse aggregate - 1/4-inch to 3/8-inch reveal.

6. Abrasive blast corners and edge of patterns carefully, using back-up boards, to maintain uniform corner or edge line. Determine type of nozzle, nozzle pressure, and blasting techniques required to match Architect's samples.

7. Upon completion of the blast finish operation, thoroughly flush finished surfaces with clean, clear water to remove residual dust and grit. Allow to air dry until curing of concrete is complete.

3.2 FLOORS AND SLABS

A. Machine Float:

1. Screed floors and slabs with straightedges to the established grades shown on the Drawings. Immediately after final screeding, a dry cement/sand shake in proportion of two sacks of Portland cement to 350 pounds of coarse natural concrete sand shall be broadcast evenly over the surface at a rate approximately equal to 500 pounds per 1,000 square feet of floor area. Do not sprinkle neat, dry, cement on the surface.

2. The application of the cement/sand shake may be eliminated at the discretion of the ENGINEER if the base slab concrete exhibits adequate fattiness and homogeneity and the need is not indicated.

3. When the concrete has hardened sufficiently to support the weight of a power float without it digging into or disrupting the level surface, thoroughly float the shake into the surface with a heavy revolving disc type power compacting machine capable of providing 200-pound compaction force distributed over a 24-inch-diameter disc.

4. Start floating along the walls and around columns and then move systematically across the surface, leaving a matte finish.

5. The compacting machine shall be a "Kelley Power Float with Compaction Control" as manufactured by Kelly Industries, or equal. Troweling machines equipped with float (shoes) blades that are slipped over the trowel blades may be used for floating. Floating with a troweling machine equipped with normal trowel blades will not be permitted. The use of any floating or troweling machine that has water attachments for wetting the concrete surface during finishing will not be permitted.

B. Hand Float:

1. In lieu of power floating, small areas may be compacted by hand floating. The dry cement/sand shake previously specified shall be used unless specifically eliminated by the ENGINEER. Screed the floors and slabs with straightedge to the established grades shown on the Drawings. While the concrete is still green, but sufficiently hardened as to support a finisher and kneeboards with no more than 1/4-inch indentation, float to a true, even plane with no coarse aggregate visible. Use sufficient pressure on the floats to bring moisture to the surface.

C. Finishing Tolerances:

1. Level floors and slabs to a tolerance of plus or minus 1/8 inch when checked with a 10-foot straightedge placed anywhere on the slab in any direction. Where drains occur, pitch floors to drains such that there are no low spots left undrained. Failure to meet either of the above requirements shall be cause for removal, grinding, or other corrective measure as directed by the ENGINEER.

D. Broomed Finish:

1. Finish concrete as specified in Paragraph 3.2A. When the concrete has stiffened sufficiently to maintain small surface indentations, draw a bristle broom lightly across the surface in the direction of drainage, or in the case of walks and stairs, perpendicular to the direction of traffic to provide a nonslip surface.

E. Steel Trowel Finish:

1. Finish concrete as specified in Paragraph 3.2A, then hand steel trowel to a perfectly smooth hard even finish free from high or low spots or other defects.

2. Where concrete is greater than 15 feet in each direction, the CONTRACTOR may use a power steel trowel provided a minimum of three troweling passes are made of the entire surface.

3.3 CONCRETE SEALER

A. Prepare and seal floor surfaces indicated on the Drawings as follows:

1. Finish the concrete as specified in the preceding paragraphs and in accordance with the Schedule of Finishing in Paragraph 3.6.

B. Newly Placed Concrete:

1. Surface must be sound and properly finished. Surface is application-ready when it is damp, but not wet and can no longer be marred by a walking worker.

C. Newly Cured Bare Concrete:

1. Level any spots gouged out by trades. Remove all dirt, dust, droppage, oil, grease, asphalt, and foreign matter. Cleanse with caustics and detergents as required. Rinse thoroughly and allow to dry so that surface is no more than damp, and not wet.

D. Aged Concrete:

1. Restore surface soundness by patching, grouting, filling cracks, and holes, etc. Surface must also be free of any dust, dirt, and other foreign matter. Use power tools and/or strippers to remove any incompatible sealers or coatings. Cleanse as required, following the procedure indicated under cured concrete.

E. Methods:

1. Comply with the manufacturer's recommendations to apply sealer so as to form a continuous, uniform film by spray, soft-bristle push broom, long-nap roller, or lamb’s wool applicator.

F. Applications:

1. Two coats are required for curing concrete. Apply the first coat evenly and uniformly as soon as possible after final finishing at the rate of 200 to 400 square feet per gallon. Apply the second coat when all trades are completed and the structure is ready for occupancy, at the rate of 400 to 600 square feet per gallon.

2. For sealing new concrete, both coats shall be applied full strength.

3. For sealing aged concrete, when renovating, dust proofing, and sealing, the first coat should be thinned 10 to 15 percent with reducer per manufacturer's directions.

3.4 CONCRETE HARDENER

A. Prepare and apply hardener to floor surfaces indicated on the Drawings as follows:

1. Finish the concrete as specified in the preceding paragraphs and in accordance with the Schedule of Finishing in Paragraph 3.6.

2. Concrete floor hardener shall be applied to green (newly placed) concrete surfaces only.

B. Methods:

1. Comply with the manufacturer's recommendations in the application of the product.

2. Do not apply dry shake into the bleed water.

C. Applications:

1. The product shall be applied using a two-pass process ("shakes"). Using a mechanical spreader, spread approximately 1/2 to 2/3 of the required floor hardener evenly over the concrete surface.

2. If the CONTRACTOR chooses to broadcast the floor hardener by hand, in lieu of a mechanical spreader, apply each pass perpendicular to the previous application to better ensure complete coverage.

3. Apply the product in quantities prescribed for "medium duty," but not less than 100 pounds per 100 square feet.

4. Approval of Finishing

D. All concrete surfaces, when finished, will be inspected by the ENGINEER.

E. Surfaces that do not meet the requirements in this Specification shall be refinished or reworked.

F. After finishing horizontal surfaces, regardless of the finishing procedure specified, the concrete shall be cured in compliance with Section 03300, unless otherwise directed by the ENGINEER.

3.5 SCHEDULE OF FINISHING

A. Concrete shall be finished as specified either to remain as natural concrete or to receive an additional applied finish or material under another Section.

B. Concrete for the following conditions shall be finished as noted on the Drawings and as further specified herein:

1. Concrete to receive dampproofing and waterproofing: Rough-Formed Finish

2. Concrete not exposed to view and not scheduled to receive an additional applied finish or material: Rough-Formed Finish

3. Exterior vertical concrete above grade, exposed to view (except surfaces formed with a form liner): Rubbed Finish

4. Interior vertical concrete exposed to view except in water containment areas: Rubbed Finish

5. Vertical concrete in water containment areas: Rubbed Finish on exposed surfaces and extending to 2 feet below normal operating water level, with Rough-Formed Finish on remainder of submerged areas

6. Interior and exterior underside of concrete exposed to view: Rubbed Finish

7. Exterior surfaces exposed to view and indicated to have an abrasive blast finish: Abrasive Blast Finish

8. Interior or exterior horizontal concrete not requiring floor hardener or sealer: Floated Finish

9. Interior or exterior horizontal concrete requiring floor hardener or sealer: See Paragraphs 3.3 and 3.4, and prepare floor in accordance with manufacturer's recommendations

10. Concrete for exterior walks, interior and exterior stairs: Broomed Finish perpendicular to direction of traffic

11. Concrete slabs on which process liquids flow or in contact with sludge: Steel Trowel Finish

12. Concrete tank bottoms to be covered with grout: See Section 03600

END OF SECTION

SECTION 03400 – PRECAST CONCRETE STRUCTURES

PART 1 GENERAL

1.1 THE REQUIREMENT

A. The CONTRACTOR shall install precast concrete boxes, traffic covers and catch basins as specified herein and as shown on the Project Drawings.

1.2 REFERENCE SPECIFICATIONS, CODES, AND STANDARDS

A. American Concrete Institute (ACI)

1. ACI 301 – Specifications for Structural Concrete

2. ACI 318 – Building Code Requirements for Structural Concrete

B. American Association of State Highway and Transportation (AASHTO)

1. AASHTO M 199 – Standard Specification for Precast Reinforced Concrete Manhole Sections.

C. ASTM International (ASTM)

1. ASTM C150 – Standard Specification for Portland Cement

2. ASTM C478 – Standard Specification for Precast Reinforced Concrete Manhole Sections

3. ASTM C913 – Standard Specification for Precast Concrete Water and Wastewater Structures

D. Precast/Prestressed Concrete Institute (PCI)

1. PCI MNL 116 – Manual for Quality Control for Plants and Production of Structural Precast Concrete Products

2. PCI MNL 120 – PCI Design Handbook - Precast and Prestressed Concrete

3. PCI MNL 123 – Design and Typical Details of Connections for Precast and Prestressed Concrete

1.3 CONTRACTOR SUBMITTALS

A. Submittals for items specified herein shall be submitted by the CONTRACTOR and shall be in accordance with the Contract Documents.

B. Submittals shall be provided to confirm that materials to be used comply with information specified herein.

C. Shop Drawings – Indicate layout, unit locations, fabrication details, unit identification marks, reinforcement, connection details, support items, dimensions, openings, openings intended to be field cut, relationship to adjacent materials, design loads, deflections, cambers, bearing requirements, and special conditions. Shop drawings shall be sealed by a Civil or Structural Engineer licensed within the State of California.

D. Product Data: Anchorage and lifting insert and devices.

E. Concrete Design and Calculations:

1. Concrete Mix Design: Include copies of test reports showing that the mix has successfully tested to produce concrete with the properties specified and will be suitable for the job condition. Test reports shall be not more than 24 months old.

2. Reinforcement Design Calculations: stamped and signed by a Civil or Structural Engineer licensed within the State of California.

3. Load Calculations stamped and signed by a Civil or Structural Engineer licensed within the State of California.

F. Certifications: Submit quality control procedures established in accordance with OCI MNL-116 by the precast manufacturer.

1.4 QUALITY ASSURANCE

A. Perform Work in accordance with the requirements of PCI MNL-116, -120 and -123.

B. Perform Work in accordance with State of California Public Works Standard.

C. Maintain a copy of each document on-site.

D. Qualifications:

1. Fabricator: Company specializing in performing Work of this Section with minimum of three (3) years documented experience.

2. Design precast concrete members under direct supervision of Professional Engineer experienced in design of this Work and licensed within the State of California.

PART 2 PRODUCTS

2.1 MANUFACTURERS

A. Precast concrete structures shall be manufactured in a plant especially designed for that purpose and shall conform to the size and dimensions indicated on the Contract Drawings.

2.2 PRECAST CONCRETE STRUCTURES

A. Precast concrete structures shall comply with AASHTO M 199, ASTM C478 and/or C913 as appropriate, except as modified herein.

B. Design shall also comply with the following restrictions:

1. The maximum reinforcement ratio allowed is one-half the reinforcement ratio that would produce a balanced strain condition.

2.3 BASE

A. Base material shall conform to Aggregate Base Backfill as specified in Section 02200, Earthwork.

B. Compaction requirements for base material shall be in accordance with Section 02200, Earthwork.

2.4 CEMENT

A. Cement shall be ASTM C150, Type II. Class of concrete shall be 5,000 psi as a minimum.

2.5 ADMIXTURES

A. Provide concrete admixtures as specified in Section 03300, Cast-in-Place Concrete.

2.6 JOINT SEALING

A. The joint sealing compound shall be permanently adhesive flexible plastic material complying in every detail to Federal Specification SS-S-00210 (GSA-FSS), Ramnek by Henry; EZ-Stik by Press-Seal; or equal.

PART 3 EXECUTION

3.1 WORKMANSHIP

A. All concrete boxes shall be installed in strict conformance with the manufacturer's written instructions, on a well compacted foundation, as specified in Section 02200, Earthwork.

3.2 EXCAVATION AND BACKFILL

A. Perform all excavation and backfill required to accomplish the construction. After concrete forms have been removed and all debris is cleaned up from the areas to be filled, place backfill from excavation in 6-inch lifts to grade and compact each lift thoroughly with pneumatic tamper or other suitable equipment to prevent future settlement. Dispose of all excess excavation off site.

END OF SECTION

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SECTION 03600 – GROUT

PART 1 GENERAL

1.1 THE REQUIREMENT

A. Furnish all labor, materials, equipment and incidentals required and install grout complete as shown on the Drawings and as specified herein.

B. Perform all sampling and furnish all testing of materials and products by an independent testing laboratory acceptable to the ENGINEER but engaged by and at the expense of the CONTRACTOR.

1.2 REFERENCE SPECIFICATIONS, CODES, AND STANDARDS

A. ASTM International (ASTM)

1. ASTM C531 – Standard Test Method for Linear Shrinkage and Coefficient of Thermal Expansion of Chemical Resistant Mortars, Grouts and Monolithic Surfacing and Polymer Concretes

2. ASTM C579 – Standard Test Method for Compressive Strength of Chemical Resistant Mortars, Grouts and Monolithic Surfacing and Polymer Concretes

3. ASTM C827 – Standard Test Method for Change in Height at Early Ages of Cylindrical Specimens of Cementitious Mixtures

4. ASTM C1107 – Standard Specification for Packaged Dry, Hydraulic-Cement Grout (Nonshrink)

5. ASTM D695 – Standard Test Method for Compressive Properties of Rigid Plastics

B. US Army Corps of Engineers (CRD)

1. CRD-C 621 – Corps of Engineers Specification for Nonshrink Grout

C. Where reference is made to one of the above standards, the revision in effect at the time of bid opening shall apply.

1.3 CONTRACTOR SUBMITTALS

A. Submit to the ENGINEER, in accordance with Division 1, submittals including the following:

1. Commercially Manufactured Nonshrink Cementitious Grout – Submit product data including catalogue cuts, technical data, storage requirements, product life, working time after mixing, temperature considerations, conformity to required ASTM standards, and Material Safety Data Sheet.

2. Commercially Manufactured Nonshrink Epoxy Grout – Submit product data including catalogue cuts, technical data, storage requirements, product life, working time after mixing, temperature considerations, conformity to required ASTM standards, and Material Safety Data Sheet.

3. Cement Grout – The submittal shall include the type and brand of the cement, the gradation of the fine aggregate, product data on any proposed admixtures, and the proposed mix of the grout.

4. Concrete Grout – The submittal shall include data as required for concrete as delineated in Section 03300 and for fiber reinforcement as delineated in Section 03200. This includes the mix design, constituent quantities per cubic yard, and the water/cement ratio.

B. Samples:

1. Submit samples of commercially manufactured grout products when requested by the ENGINEER.

2. Submit aggregates for use in concrete grout when requested by the ENGINEER.

C. Laboratory Test Reports:

1. Submit laboratory test data as required under Section 03300 for concrete to be used as concrete grout.

1.4 QUALITY ASSURANCE

A. Qualifications – Grout manufacturer shall have a minimum of 10 years experience in the production and use of the type of grout proposed for the work.

B. Preinstallation Conference – Well in advance of grouting, hold a preinstallation meeting to review the requirements for surface preparation, mixing, placing, and curing procedures for each product proposed for use. Parties concerned with grouting shall be notified of the meeting at least 10 days before its scheduled date.

C. Services of Manufacturer's Representative – A qualified field technician of the nonshrink grout manufacturer, specifically trained in the installation of the products, shall attend the preinstallation conference and shall be present for the initial installation of each type of nonshrink grout. Additional services shall also be provided, as required, to correct installation problems.

D. Field Testing – The field testing of Concrete Grout shall be as specified for concrete in Section 03300.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Deliver materials to the jobsite in original, unopened packages, clearly labeled with the manufacturer's name, product identification, batch numbers, and printed instructions.

B. Store materials in full compliance with the manufacturer's recommendations. Total storage time from date of manufacture to date of installation shall be limited to 6 months or the manufacturer's recommended storage time, whichever is less.

C. Material that becomes damp or otherwise unacceptable shall be immediately removed from the site and replaced with acceptable material at no additional expense to the CITY.

D. Nonshrink, cement-based grouts shall be delivered as pre-blended, prepackaged mixes requiring only the addition of water.

E. Nonshrink epoxy grouts shall be delivered as pre-measured, prepackaged, three-component systems requiring only blending as directed by the manufacturer.

1.6 DEFINITIONS

A. Nonshrink Grout – A commercially manufactured product that does not shrink in either the plastic or hardened state, is dimensionally stable in the hardened state, and bonds to a clean baseplate.

PART 2 PRODUCTS

2.1 GENERAL

A. The use of a manufacturer's name and model or catalog number is for the purpose of establishing the standard of quality and general configuration desired.

B. All like materials shall be the products of one manufacturer or supplier in order to provide standardization of appearance.

2.2 MATERIALS

A. Nonshrink Cementitious Grout:

1. Nonshrink cementitious grouts shall meet or exceed the requirements of ASTM C1107, Grades B or C and CRD-C 621. Grouts shall be Portland cement-based, contain a pre-proportioned blend of selected aggregates and shrinkage-compensating agents and shall require only the addition of water. Nonshrink cementitious grouts shall not contain expansive cement or metallic particles. The grouts shall exhibit no shrinkage when tested in conformity with ASTM C827. The minimum 28-day compressive strength of 5,000 pounds per square inch (psi) is required for all nonshrink cementitious grout.

2. General purpose nonshrink cementitious grout shall conform to the standards stated above and shall be SikaGrout 212 by Sika Corp.; NS Grout by The Euclid Chemical Co.; FSP Construction Grout by Five Star Products Inc.; or equal.

3. Flowable (Precision) nonshrink cementitious grout shall conform to the standards stated above and shall be Masterflow 928 by BASF Building Systems; Hi-Flow Grout by the Euclid Chemical Co.; SikaGrout 212 by Sika Corp.; Five Star Grout, by Five Star Products Inc.; or equal.

B. Nonshrink Epoxy Grout:

1. Nonshrink epoxy-based grout shall be a pre-proportioned, three-component, 100 percent solids system consisting of epoxy resin, hardener, and blended aggregate. It shall have a minimum compressive strength of 10,000 psi in 7 days when tested in accordance with ASTM C579, Method B, and have a maximum thermal expansion of $30x10^{-6}$ when tested in accordance with ASTM C531. The grout shall be Masterflow 648 CP by BASF Building Systems; Five Star HP Epoxy Grout by Five Star Products, Inc.; Sikadur 42 Grout-Pak by Sika Corp.; E^3-HP by the Euclid Chemical Co.; or equal.

C. Cement Grout:

1. Cement grouts shall be a mixture of one part Portland cement conforming to ASTM C150 Types I, II, or III and one to two parts sand conforming to ASTM C33 with sufficient water to place the grout. The water content shall be sufficient to impart workability to the grout but not to the degree that it will allow the grout to flow.

D. Concrete Grout:

1. Concrete grout shall conform to the requirements of Section 03300 except as specified herein. It shall be proportioned with cement, [pozzolan,] coarse and fine aggregates, water, water reducer, and air-entraining agent to produce a mix having an average strength of 2,900 psi at 28 days, or 2,500 psi nominal strength. Coarse aggregate size shall be [3/8] [1/2]-in maximum. Slump should not exceed 5 inches and should be low as practical yet still retain sufficient workability.

2. Synthetic reinforcing fibers as specified in Section 03200 shall be added to the concrete grout mix at the rate of 1.5 pounds of fibers per cubic yard of grout. Fibers shall be added from the manufacturer's premeasured bags and according to the manufacturer's recommendations in a manner that will ensure complete dispersion of the fiber bundles as single monofilaments within the concrete grout.

E. Water:

1. Water shall be potable, free from injurious amounts of oil, acid, alkali, organic matter, or other deleterious substances. Use of reclaimed or recycled water is not permissible.

PART 3 EXECUTION

3.1 PREPARATION

A. Grout shall be placed over cured concrete that has attained its full design strength unless otherwise approved by the ENGINEER.

B. Concrete surfaces to receive grout shall be clean and sound; free of ice, frost, dirt, grease, oil, curing compounds, laitance, and paints; and free of all loose material or foreign matter that may affect the bond or performance of the grout.

C. Roughen concrete surfaces by chipping, sandblasting, or other mechanical means to ensure bond of the grout to the concrete. Remove loose or broken concrete. Irregular voids or projecting coarse aggregate need not be removed if they are sound, free of laitance, and firmly embedded into the parent concrete.

1. Air compressors used to clean surfaces in contact with grout shall be the oilless type or equipped with an oil trap in the airline to prevent oil from being blown onto the surface.

D. Remove all loose rust, oil, or other deleterious substances from metal embedments or bottom of baseplates before the installation of the grout.

E. Concrete surfaces shall be washed clean and then kept moist for at least 24 hours before the placement of cementitious or cement grout. Saturation may be achieved by covering the concrete with saturated burlap bags, use of a soaker hose, flooding the surface, or other method acceptable to the ENGINEER. Upon completion of the 24-hour period, visible water shall be removed from the surface before grouting. The use of an adhesive bonding agent in lieu of surface saturation shall only be used when approved by the ENGINEER for each specific location of grout installation.

F. Epoxy-based grouts do not require the saturation of the concrete substrate. Surfaces in contact with epoxy grout shall be completely dry before grouting.

G. Construct grout forms or other leak proof containment as required. Forms shall be lined or coated with release agents recommended by the grout manufacturer. Forms shall be of adequate strength, securely anchored in place and shored to resist the forces imposed by the grout and its placement.

1. Forms for epoxy grout shall be designed to allow the formation of a hydraulic head and shall have chamfer strips built into forms.

H. Level and align the structural element or equipment bearing plates in accordance with the structural requirements and the recommendations of the equipment manufacturer.

I. Equipment shall be supported during alignment and installation of grout by shims, wedges, blocks, or other approved means. The shims, wedges, and blocking devices shall be prevented from bonding to the grout by appropriate bond breaking coatings and removed after grouting unless otherwise approved by the ENGINEER.

3.2 INSTALLATION – GENERAL

A. Mix, apply, and cure products in strict compliance with the manufacturer's recommendations and this Section.

B. Have sufficient manpower and equipment available for rapid and continuous mixing and placing. Keep all necessary tools and materials ready and close at hand.

C. Maintain temperatures of the foundation plate, supporting concrete, and grout between 40 and 90 degrees Fahrenheit (F) during grouting and until grout compressive strength reaches 1,000 psi or as recommended by the grout manufacturer, whichever is longer. Take precautions to minimize differential heating or cooling of baseplates and grout during the curing period.

D. Take special precautions for hot weather or cold weather grouting as recommended by the manufacturer when ambient temperatures and/or the temperature of the materials in contact with the grout are outside of the 60-90 degrees F range.

E. Install grout in a manner that will preserve the isolation between the elements on either side of the joint where grout is placed in the vicinity of an expansion or control joint.

F. Reflect all existing underlying expansion, control, and construction joints through the grout.

3.3 INSTALLATION – CEMENT GROUTS AND NONSHRINK CEMENTITIOUS GROUTS

A. Mix in accordance with manufacturer's recommendations. Do not add cement, sand, pea gravel, or admixtures without prior approval by the ENGINEER.

B. Avoid mixing by hand. Mixing in a mortar mixer (with moving blades) is recommended. Pre-wet the mixer and empty excess water. Add pre-measured amount of water for mixing, followed by the grout. Begin with the minimum amount of water recommended by the manufacturer and then add the minimum additional water required to obtain workability. Do not exceed the manufacturer's maximum recommended water content.

C. Placements greater than 3 inches in depth shall include the addition of clean, washed pea gravel to the grout mix when approved by the manufacturer. Comply with the manufacturer's recommendations for the size and amount of aggregate to be added. Place grout into the designated areas in a manner that will avoid segregation or entrapment of air. Do not vibrate grout to release air or to consolidate the material. Placement should proceed in a manner that will ensure the filling of all spaces and provide full contact between the grout and adjoining surfaces. Provide grout holes as necessary.

D. Place grout rapidly and continuously to avoid cold joints. Do not place cement grouts in layers. Do not add additional water to the mix (retemper) after initial stiffening.

E. Just before the grout reaches its final set, cut back the grout to the substrate at a 45 degree angle from the lower edge of the bearing plate unless otherwise approved by the ENGINEER. Finish this surface with a wood float (brush) finish.

F. Begin curing immediately after form removal, cutback, and finishing. Keep grout moist and within its recommended placement temperature range for at least 24 hours after placement or longer if recommended by the manufacturer. Saturate the grout surface by use of wet burlap, soaker hoses, ponding, or other approved means. Provide sunshades as necessary. If drying winds inhibit the ability of a given curing method to keep grout moist, erect wind breaks until wind is no longer a problem or curing is finished.

3.4 INSTALLATION – NONSHRINK EPOXY GROUTS

A. Mix in accordance with the procedures recommended by the manufacturer. Do not vary the ratio of components or add solvent to change the consistency of the grout mix. Do not over mix. Mix full batches only to maintain proper proportions of resin, hardener, and aggregate.

B. Monitor ambient weather conditions and contact the grout manufacturer for special placement procedures to be used for temperatures below 60 or above 90 degrees F.

C. Place grout into the designated areas in a manner that will avoid trapping air. Placement methods shall ensure the filling of all spaces and provide full contact between the grout and adjoining surfaces. Provide grout holes as necessary.

D. Minimize "shoulder" length (extension of grout horizontally beyond baseplate). In no case shall the shoulder length of the grout be greater than the grout thickness.

E. Finish grout by puddling to cover all aggregate and provide a smooth finish. Break bubbles and smooth the top surface of the grout in conformity with the manufacturer's recommendations.

F. Epoxy grouts are self-curing and do not require the application of water. Maintain the formed grout within its recommended placement temperature range for at least 24 hours after placing, or longer if recommended by the manufacturer.

3.5 INSTALLATION – CONCRETE GROUT

A. Screed underlying concrete to the grade shown on the Drawings. Provide the surface with a broomed finish, aligned to drain. Protect and keep the surface clean until placement of the concrete grout.

B. Remove the debris and clean the surface by sweeping and vacuuming all dirt and other foreign materials. Wash the tank slab using a strong jet of water. Flushing of debris into tank drain lines will not be permitted.

C. Saturate the concrete surface for at least 24 hours before placement of the concrete grout. Saturation may be maintained by ponding, by the use of soaker hoses, or by other methods acceptable to the ENGINEER. Remove excess water just before placement of the concrete grout. Place a cement slurry immediately ahead of the concrete grout so that the slurry is moist when the grout is placed. Work the slurry over the surface with a broom until it is coated with an approximately 1/16 to 1/8-inch-thick cement paste. [(A bonding agent composed of 1 part Portland cement, 1.5 parts fine sand, an approved bonding admixture, and water, mixed to achieve the consistency of thick paint, may be substituted for the cement slurry.)]

D. Place concrete grout to final grade using the scraper mechanism as a guide for surface elevation and to ensure high and low spots are eliminated. Unless specifically approved by the equipment manufacturer, mechanical scraper mechanisms shall not be used as a finishing machine or screed.

E. Provide grout control joints as indicated on the Drawings.

F. Finish and cure the concrete grout as specified for cast-in-place concrete.

3.6 SCHEDULE

A. General Purpose Nonshrink Cementitious Grout – Use at all locations where nonshrink grout is called for on the Drawings except for baseplates greater in area than 3 feet wide by 3 feet long and except for the setting of anchor rods, anchor bolts, or reinforcing steel in concrete.

B. Flowable Nonshrink Cementitious Grout – Use under all baseplates greater in area than 3 feet by 3 feet. Use at all locations indicated to receive flowable nonshrink grout on the Drawings. The CONTRACTOR, at his/her option and convenience, may substitute flowable nonshrink grout for general purpose nonshrink cementitious grout.

C. Nonshrink Epoxy Grout – Use for the setting of anchor rods, anchor bolts, and reinforcing steel in concrete and for all locations specifically indicated to receive epoxy grout.

D. Cement Grout – Cement grout may be used for grouting of incidental baseplates for structural and miscellaneous steel such as post baseplates for platforms, baseplates for beams, etc. It shall not be used when nonshrink grout is specifically called for on the Drawings or for grouting of primary structural steel members such as columns and girders.

E. Concrete Grout – Use for overlaying the base concrete under scraper mechanisms of clarifiers to allow more control in placing the surface grade. Use at all locations indicated on the Drawings to receive Concrete grout.

END OF SECTION

SECTION 03922 – MODIFICATIONS AND REPAIR TO CONCRETE

PART 1 GENERAL

1.1 THE REQUIREMENT

A. Furnish all labor, materials, equipment and incidentals required to cut, remove, repair or otherwise modify parts of existing concrete structures as shown on the Drawings and as specified herein as necessary to complete the Work. Work under this Section shall also include bonding new concrete to existing concrete.

1.2 REFERENCE SPECIFICATIONS, CODES, AND STANDARDS

A. ASTM International (ASTM)

1. ASTM C881 – Standard Specification for Epoxy-Resin-Base Bonding Systems for Concrete.

2. ASTM C882 – Test Method for Bond Strength of Epoxy-Resin Systems Used with Concrete.

3. ASTM C883 – Test Method for Effective Shrinkage of Epoxy-Resin Systems Used with Concrete.

4. ASTM D570 – Test Method for Water Absorption of Plastics.

5. ASTM D638 – Standard Test Method for Tensile Properties of Plastic.

6. ASTM D695 – Test Method for Compressive Properties of Rigid Plastic.

7. ASTM D732 – Standard Test Method for Shear Strength of Plastics by Punch Tool.

8. ASTM D790 – Standard Test Methods for Flexural Properties of Unreinforced Plastic and Electrical Insulating Materials.

B. Where reference is made to one of the above standards, the revision in effect at the time of bid opening shall apply.

1.3 CONTRACTOR SUBMITTALS

A. All submittals shall be in accordance with Division 1.

B. Submit manufacturer's technical literature on all product brands proposed for use by the CONTRACTOR, to the ENGINEER for review. The submittal shall include the manufacturer's installation and/or application instructions.

C. When substitutions for acceptable brands of materials specified herein are proposed by the CONTRACTOR, submit brochures and technical data of the proposed substitutions to the ENGINEER for approval before delivery to the jobsite.

1.4 QUALITY ASSURANCE

A. No existing structure or concrete shall be shifted, cut, removed, or otherwise altered until authorization is given by the ENGINEER.

B. When removing materials or portions of existing structures and when making openings in existing structures, all precautions shall be taken and all necessary barriers, shoring and bracing and other protective devices shall be erected to prevent damage to the structures beyond the limits necessary for the new work, protect personnel, control dust and to prevent damage to the structures or contents by falling or flying debris. Unless otherwise permitted, shown or specified, line drilling will be required in cutting existing concrete.

C. Manufacturer qualifications: The manufacturer of the specified products shall have a minimum of ten years experience in the manufacture of such products and shall have an ongoing program of training, certifying and technically supporting the CONTRACTOR's personnel.

D. Contractor qualifications: Contractors shall complete a program of instruction in the application of the approved manufacturer's material specified in this Section and provide certification from the manufacturer attesting to their training and status as an approved applicator.

1.5 DELIVERY, STORAGE AND HANDLING

A. Deliver materials to the jobsite in original, unopened packages, clearly labeled with the manufacturer's name, product identification, batch numbers and printed instructions.

B. Store materials in full compliance with the manufacturer’s recommendations.

PART 2 PRODUCTS

2.1 GENERAL

A. The use of a manufacturer’s name and model or catalog number is for the purpose of establishing the standard of quality and general configuration desired.

B. Materials shall comply with this Section and any applicable State or Local requirements.

2.2 MATERIALS

A. Epoxy Bonding Agent:

1. Epoxy bonding agent shall be a two-component, solvent-free, moisture insensitive epoxy resin material used to bond plastic concrete to hardened concrete complying with the requirements of ASTM C881, Type II.

2. Color shall be concrete gray.

3. Product shall be Sikadur 32 Hi-Mod by Sika Corporation; Concresive Liquid LPL by BASF Building Systems; or approved equal.

B. Epoxy Paste:

1. Epoxy paste shall be a two-component, solvent-free, moisture insensitive epoxy resin material used to bond dissimilar materials to concrete such as setting railing posts, dowels, anchor bolts, and all-thread rods into hardened concrete and shall comply with the requirements of ASTM C881, Type I, Grade 3. It may also be used to patch existing surfaces where the glue line is 1/8-in or less.

2. Color shall be concrete gray.

3. Product shall be Sikadur 31 Hi-Mod Gel by Sika Corporation; Concresive Paste LPL by BASF Building Systems; or approved equal.

C. Nonshrink Grout and Nonshrink Epoxy Grout shall be as specified in Section 03600.

D. Adhesive anchors shall be as specified in Section 05500.

E. Crack Repair Epoxy Adhesive:

1. Crack Repair Epoxy Adhesive shall be a two-component, solvent-free moisture insensitive epoxy resin material suitable for crack grouting by injection or gravity feed. It shall be formulated for the specific size of opening or crack being injected.

2. For standard applications, product shall be Sikadur 35 Hi-Mod LV by Sika Corporation; SCB Concresive 1380 by BASF Building Systems; or approved equal.

PART 3 EXECUTION

3.1 GENERAL

A. Cut, repair, reuse, demolish, excavate or otherwise modify parts of the existing structures, as indicated on the Drawings, specified, or necessary to permit completion of the Work. Finishes, joints, reinforcements, sealants, etc. are specified in other Sections of this Specification. All work shall comply with other requirements of this Section and as shown on the Drawings.

B. All commercial products specified in this Section shall be stored, mixed, and applied in strict compliance with the manufacturer's recommendations.

C. In all cases where concrete is repaired in the vicinity of an expansion joint or control joint the repairs shall be made to preserve the isolation between components on either side of the joint.

D. Prior to drilling holes for dowels/bolts or coring new openings at existing concrete walls and slabs. Contractor shall map existing embedded items, including but not limited to rebar and electrical conduits. As approved by the ENGINEER, the hole location shall be relocated to avoid the embedded item.

E. When drilling holes for dowels/bolts at new or existing concrete, drilling shall stop if rebar. As approved by the ENGINEER, the hole location shall be relocated to avoid rebar. The CONTRACTOR shall not cut rebar without prior approval. Where possible, rebar locations shall be identified prior to drilling using "rebar locators" so that drilled hole locations may be adjusted to avoid rebar interference.

F. The CONTRACTOR shall not cut existing rebar or other embedded items without prior approval from the ENGINEER.

3.2 CONCRETE REMOVAL

A. Concrete designated to be removed to specific limits as shown on the Drawings or directed by the ENGINEER, shall be done by line drilling at limits followed by chipping or jack-hammering as appropriate in areas where concrete is to be taken out. Remove concrete in such a manner that surrounding concrete or existing reinforcing to be left in place and existing in place equipment is not damaged. Sawcutting at limits of concrete to be removed shall only be done if indicated on the Drawings, or after obtaining written approval from the ENGINEER.

B. Where existing reinforcing is exposed due to saw cutting/core drilling and no new material is to be placed on the saw cut surface, a coating or surface treatment of epoxy paste shall be applied to the entire cut surface to a thickness of 1/4-in.

C. In all cases where the joint between new concrete or grout and existing concrete will be exposed in the finished work, except as otherwise shown or specified, the edge of concrete removal shall be a 1-in deep saw cut on each exposed surface of the existing concrete.

D. Concrete specified to be left in place that is damaged by the CONTRACTOR shall be repaired by approved means to the satisfaction of the ENGINEER and at no additional cost to the CITY.

E. The ENGINEER may from time to time direct the CONTRACTOR to make additional repairs to existing concrete. These repairs shall be made as specified or by such other methods as may be appropriate.

3.3 CONNECTION SURFACE PREPARATION

A. Connection surfaces shall be prepared as specified below for concrete areas requiring patching, repairs or modifications as shown on the Drawings, specified, or as directed by the ENGINEER.

B. Remove all deteriorated materials, dirt, oil, grease, and all other bond inhibiting materials from the surface by dry mechanical means, i.e. - sandblasting, grinding, etc., as approved by the ENGINEER. Surfaces shall be roughened to a full amplitude of at least 1/2-in in depth. Irregular voids or surface stones need not be removed if they are sound, free of laitance, and firmly embedded into parent concrete, subject to the ENGINEER's final inspection.

C. If reinforcing steel is exposed, it must be mechanically cleaned to remove all contaminants, rust, etc., as approved by the ENGINEER. If half of the diameter of the reinforcing steel is exposed, chip out behind the steel. The distance chipped behind the steel shall be a minimum of 1/2-in. Reinforcing to be saved shall not be damaged during the demolition operation.

D. Reinforcing from existing demolished concrete that is shown to be incorporated in new concrete shall be cleaned by mechanical means to remove all loose material and products of corrosion before proceeding with the repair. It shall be cut, bent or lapped to new reinforcing as shown on the Drawings and provided with one-inch minimum cover all around.

E. The following are specific concrete surface preparation and connection "methods" to be used where called for on the Drawings, specified or as directed by the ENGINEER.

1. Method A – After the existing concrete surface at the connection has been roughened and cleaned, thoroughly saturate and maintain saturation for a period of at least 12 hours. Brush on a 1/16-in layer of cement and water mixed to the consistency of a heavy paste. Immediately after application of cement paste, place new concrete or grout mixture as detailed on the Drawings.

2. Method B – After the existing concrete surface has been roughened and cleaned, apply epoxy-bonding agent at connection surface. The field preparation and application of the epoxy-bonding agent shall comply strictly with the manufacturer's recommendations. Place new concrete or grout mixture to limits shown on the Drawings within time constraints recommended by the manufacturer to ensure bond.

3. Method C – Adhesive anchors shall be set in existing concrete by drilling holes to the required depth to develop the full tensile and shear strengths of the anchor material being used. The adhesive anchor system shall be installed per the manufacturer's recommendation in holes sized as required. Unless otherwise shown on the Drawings, deformed bars shall be drilled and set to a depth of ten bar diameters and smooth bars shall be drilled and set to a depth of 15 bar diameters. The anchor may be installed in horizontal, vertical and overhead positions as indicated on the Drawings. The allowable tensile value for anchors installed in overhead positions shall be limited to 50% of the ICC ES published allowable value.

4. Method D – Combination of Method B and C.

3.4 GROUTING

A. Grouting shall be as specified in Section 03600.

3.5 CRACK REPAIR

A. Cracks on horizontal surfaces shall be repaired by gravity feeding crack repair adhesive into cracks per manufacturer's recommendations. If cracks are less than 1/16-in in thickness they shall be pressure injected.

B. Cracks on vertical surfaces shall be repaired by pressure injecting crack repair adhesive through valves sealed to the surface with crack repair epoxy adhesive per manufacturer's recommendations.

END OF SECTION

SECTION 05120 – STRUCTURAL STEEL

PART 1 GENERAL

1.1 THE REQUIREMENT

A. Furnish all materials, labor, equipment and services necessary for the fabrication, erection and completion of all structural steel, including all bracing and shoring required for erection and related work. The work shall include and not necessarily be limited to the following:

1. Structural steel, including but not limited to columns, girders, trusses, beams, girts, bracing, anchor bolts, base plates, connection bolts, etc.

2. Anchor bolts shall be furnished under this section and set under Section 03300. Furnish anchor bolts, nuts and metal setting templates. Furnish instructions for the setting of anchor bolts and ascertain that the items are properly set during and after the progress of the work. Verify anchor bolt setting to assure adequate fit of the steel work.

3. For grouting of base plates, see Section 03600.

1.2 REFERENCE SPECIFICATIONS, CODES, AND STANDARDS

A. American Institute of Steel Construction (AISC):

1. AISC S302 – Code of Standard Practice for Steel Buildings and Bridges

2. AISC S335 – Specification for Structural Steel Buildings Allowable Stress Design and Plastic Design Commentary

3. AISC M016 – Manual of Steel Construction Allowable Stress Design

B. ASTM International (ASTM):

1. ASTM A36 – Standard Specification for Carbon Structural Steel

2. ASTM A53 – Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless

3. ASTM A123 – Standard Specification for Zinc (Hot-Dipped Galvanized) Coatings on Iron and Steel Products.

4. ASTM A153 – Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware

5. ASTM A240 – Standard Specification for Chromium and Chromium-Nickle Stainless Steel Plate, Sheet and Strip for Pressure Vessels and for General Applications

6. ASTM A307 – Standard Specification for Carbon Steel Bolts, Steel, Heat Treated, 120/105 ksi Minimum Tensile Strength

7. ASTM A500 – Standard Specification for Cold-Formed Welded and Seamless Carbon Steel Structural Tubing in Rounds and Shapes

8. ASTM A780 – Standard Practice for Repair of Damage and Uncoated Areas of Hot-Dipped Galvanized Coating.

9. ASTM A992 – Standard Specification for Structural Steel Shapes

10. ASTM B695 – Standard Specification for Coatings of Zinc Mechanically Deposited on Iron and Steel.

11. ASTM F1554 – Standard Specification for Anchor Bolts, Steel, 36, 55, and 105-ksi Yield Strength

C. American Welding Society (AWS):

1. AWS A5 – Specifications for Carbon Steel Electrodes for Shielded Metal Arc Welding

2. AWS D1.1 – Structural Welding Code Steel

D. Research Council on Structural Connections of the Engineering Foundation (RCSCEF):

1. Specifications for Structural Joints using ASTM A325 or ASTM A490 Bolts.

E. Where reference is made to one of the above standards, the revision in effect at the time of bid opening shall apply.

1.3 CONTRACTOR SUBMITTALS

A. Mill Test Reports: CONTRACTOR shall furnish certified copies of all mill analysis and test reports covering the chemical and physical properties of the steel for review by the CITY's Testing Agency.

B. Certifications:

1. Certified mill test reports for the structural steel and bolting materials.

2. Certification that welders are qualified, in accordance with AWS D1.1, on shop and field welding procedures to be used.

C. Shop Drawings:

1. Detailed shop drawings, erection drawings, schedules, and data for all structural steel. Review will be for general conformance with the Contract Documents and shall not relieve the CONTRACTOR of responsibility for proper fit of members, connections not detailed on the Drawings, or for supplying all material required by the Contract Documents. Mark numbers painted on the shop assembled pieces of steel shall be the same mark numbers used on the detailed shop and erection drawings.

D. Welding Procedure Specifications (WPS): CONTRACTOR shall submit welding procedure specifications (WPS) and procedure qualification records (PQR) for all welded joint types.

E. Review of submittals and shop drawings will cover only the general scheme and character of the details, but not the checking of dimensions, nor will such review relieve the CONTRACTOR from responsibility for executing the work in accordance with the Contract Drawings.

1.4 QUALITY ASSURANCE

A. Identification of Steel:

1. CONTRACTOR shall certify, test, and inspect all materials, welding, fabrication and erection in accordance with the requirements of AISC and AWS D1.1.

2. Submit mill analysis and test reports for the steel, certified by the manufacturer, to show material is in conformance with the specified ASTM standard. CONTRACTOR shall identify steel in accordance with CBC Section 2203 as to heat number and furnish the CITY's Testing Agency, for their review, mill tests and manufacturer's certification for each heat of steel. Steel that is not readily identifiable as to grade from marking and test records shall be tested to determine conformity to such standards. The cost of such testing shall be paid by the CONTRACTOR.

3. Submit certificates of compliance for welding electrodes indicating material is in conformance with these Specifications.

4. High strength bolts, nuts, washers and threaded rods shall be sampled and tested in accordance with the requirements of the specification for High Strength Bolts for Structural Steel Joints, ASTM A325 or ASTM A490 Bolts.

B. Welding Inspection by the CITY's Testing Agency: All shop and field welding shall be inspected by an AWS certified welding inspector in accordance with AWS D1.1 Section 6. The CITY's Testing Agency shall provide the following:

1. Review of CONTRACTOR's Welding Procedure Specifications (WPS) submittal and verify that welders are performing work in accordance with the approved WPS.

2. Verification of welder qualifications.

3. Verification that electrical meters being used accurately reflect voltage and amperage at the welding site for the length of cable in use.

4. Visual Inspection: Visually inspect all welding in accordance with AWS D1.1 Section 6, and including verification of fit-up, preheat, calibration of equipment, equipment settings, materials, adherence to approved WPS, interpass temperatures, deposition rates, technique, proper fusion of each pass, ensure the weld is crack free at each pass, confirm porosity and undercut do not exceed AWS requirements, confirm the final weld profile, and confirm that all special requirements specified herein are adhered to.

5. NDT (non-destructive testing) Ultrasonic Inspection: Test 100% of all complete joint penetration (CJP) groove welds using ultrasonic testing. The ultrasonic instrumentation shall be calibrated by the technician to evaluate the quality of the welds in accordance with AWS D1.1., Section 6.25. Technician who operates the equipment shall examine the welds and maintain a record of all welds examined, defects found and disposition of each defect. All defective welds shall be repaired by the CONTRACTOR and retested with ultrasonic equipment, at the expense of the CONTRACTOR.

6. NDT (non-destructive testing) Magnetic Particle Inspection: Test 100% of all back-gouged weld roots and 100% of all weld tab removal sites using magnetic particle testing in accordance with ASTM E 709-91. Technician who operates the equipment shall examine the welds and maintain a record of all welds so examined, defects found and disposition of each defect. All defects shall be repaired by the CONTRACTOR and retested at the expense of the CONTRACTOR.

C. Fabrication and Erection Inspection by the CITY's Testing Agency: All fabrication and erection of structural steel shall be inspected by the CITY's Testing Agency. This inspection, in addition to the welding inspection requirements specified herein, shall consist of, but shall not necessarily be limited to, the following:

1. Visually inspect steel shapes and plates for existence of defects such as laminations and non-metallic inclusions. Use ultrasonic equipment and other NDT methods to determine extent of defects.

2. Verify steel materials with mill certificates. Verify weld filler metal materials with certificates and manufacturers recommended limitations.

3. Review rolled shapes for conformity to dimensional standards specified.

4. Inspect high strength bolting in conformance with the "Specification for Structural Joints using ASTM A325 or A490 Bolts" as approved by the Research Council on Riveted and Bolted Structural Joints of the Engineering Foundation.

D. Welding, fabrication and erection Inspection by the CITY's Testing Agency as required to satisfy the building code requirements for special inspection will be paid for by the CITY, unless specifically stated otherwise.

1. If inspection of shop fabrication requires the CITY's Testing Agency to travel further than 100 miles from the project site, the full cost of travel expenses incurred for such inspection shall be covered by the CONTRACTOR.

1.5 DELIVERY, STORAGE AND HANDLING

A. Deliver materials promptly so as to cause no delay with other parts of the Work.

B. Store materials on skids and not on the ground. Pile and block materials so that they will not become bent or otherwise damaged

C. Handle materials with cranes or derricks as far as practicable. Do not "dump" steel off cars or trucks, nor handle in any other manner likely to cause damage.

D. Materials with excessive damage, in the opinion of the ENGINEER, shall not be incorporated into the work. Remove and replace them with new, undamaged materials, at no additional cost to the CITY.

PART 2 PRODUCTS

2.1 GENERAL

A. The use of a manufacturer's name and model or catalog number is for the purpose of establishing the standard of quality and general configuration desired.

B. All like materials shall be the products of one manufacturer or supplier in order to provide standardization of appearance.

2.2 MATERIALS

A. Steel Shapes, Plates and Bars: ASTM A36, typical unless otherwise noted.

B. Steel Wide-Flange Shapes: ASTM A992.

C. Steel Tubing: ASTM A500, Grade B

D. Steel Pipe: ASTM A53, Type S, Grade B.

E. Flashing: Stainless 26-gauge, stainless steel 304, finish ASTM A240

F. Arc-Welding Electrodes: Filler metals shall conform to Table 3.1 of AWS D1.1. Electrodes and equipment settings shall be as recommended by the filler metal manufacturer for the position, thickness or other conditions of actual use. All electrodes and filler metals shall be low hydrogen types. <u>Filler metals with the E70-T4 designation shall not be used.</u>

G. Anchor Bolts: ASTM F1554 Grade 36.

H. Machine Bolts: ASTM A307

I. High-Strength Bolts: ASTM A325, Connection Type X, N or SC, as indicated on the Drawings.

J. Shop Primer: As specified in Section 09900.

K. Galvanizing: Zinc with 0.5 percent (minimum) nickel added.

L. Galvanized Surface Primer: 95 percent zinc dust, organic vehicle primer.

PART 3 EXECUTION

3.1 SURFACE PREPARATION

A. Prepare and shop prime paint non-galvanized members as specified in Section 09900. Do not prime paint faying surfaces of slip critical connections.

B. The CONTRACTOR shall notify the CITY at least four weeks in advance of surface preparation and painting in the fabricator's shop so that a local independent NACE paint inspector can provide local inspection and dry film testing before the steel leaves the shop. The cost for the independent NACE paint inspector will be paid for by the CITY.

3.2 GENERAL FABRICATION

A. Workmanship and details of structural steel work, unless otherwise specified, shall conform to the California Building Code and the AISC Specification for Design, Fabrication and Erection of Structural Steel for Buildings. The quality of materials and the fabrication of all welded connections shall conform to the American Welding Society's Structural Welding Code, AWS D1.1.

B. The CONTRACTOR shall secure all field measurements necessary for the completion of this work. The CONTRACTOR shall be responsible for all errors of detailing and fabrication and for the correct fitting of the structural members to each other and to their supports.

C. Provide bolts and connections for attachment of the work of other sections to the structural steel. Provide column anchor bolts and templates for setting under Section 03300.

D. All materials both before and after fabrication shall be protected from corrosion and shall be kept free from dirt, grease and other foreign matter.

E. Each framing member shall be free from twists and bends. Holes and all cut and sheared edges shall be neatly made without kinks, butts and warped edges. All steel left exposed shall be straight, smooth and free of nicks, scars and dents. Exposed welds shall be uniform and neat.

F. Holes for Bolts: Holes for bolts shall be 1/16 inch larger than the nominal diameter of the bolt. If the thickness of the material is not greater than the nominal diameter of the bolt plus 1/8 inch, the holes may be punched. Holes in thicker material shall be drilled from the solid or sub-punched and reamed. Holes for high-strength bolts shall have all burrs removed by grinding.

G. Column Bearing Surfaces: Column bases, as required by the AISC specification, and all column bearing surfaces shall be milled to a true plane perpendicular to the axis of the member to assure a complete bearing at the contact face.

3.3 WELDING

A. All welding shall be performed in strict adherence with an approved, written WPS.

B. Preparation for Welding: All surfaces shall be clean, free of rust, paint and foreign matter of any kind. Scale shall be removed by wire brush, chipping or hammering as required. Thermal cut edges to be welded shall be chipped clean, and ground at least 1/32 inch to bright metal before welding. Clamp members as required, space and alternate welds, all as may be necessary to prevent warping or misalignment.

C. Weld Quality: Welds shall present a uniform surface, free of imperfections as defined by AWS, and without undercutting or over-lapping and free of excessive oxides, gas pockets and non-metallic inclusions. Welds shall be made with the proper number of beads or passes to secure sound, thoroughly fused joints. Each deposit shall not exceed maximum layer height and bead width specified in AWS D1.1. Each pass shall be cleaned by chipping and wire brushing to remove scale and slag, before placing any additional weld metal.

D. Sequence of Welding: For highly restrained connection and/or weldments, the sequence of welding shall be designed to minimize distortion of the members and to minimize the buildup of internal stresses.

E. Preheat: No welding at the joint may proceed, including tack welds, backup bars and weld tabs, until the pre-heating has been completed. Preheat base metals in accordance with AWS D1.1 Table 3.2, except the following minimum values shall apply:

1. For restrained welding conditions, minimum preheat shall be determined using AWS D1.1 Annex XI. Restrained welding conditions shall include but are not limited to: Continuity plates in columns.

2. For all other welds, minimum preheat shall not be less than as tabulated below:

Minimum Preheat – See Note (2) (ASTM A 36 or ASTM A 572-50 Base Metals)	
Base Metal Thickness	**Minimum Preheat**
Up to 3/4 Inch	None. See Note (1)
Over 3/4 up to 1-1/2 Inch	75°F
Over 1-1/2 up to 2-1/2 Inch	200°F
Over 2-1/2 up to 3-1/2 Inch	300°F
Over 3-1/2 Inch	350°F min
(1) There should be at least enough heat to drive off any moisture. Comply with AWSD1.1, Table 3.2. (2) This table shall not be construed as replacing any more stringent requirements found in AWSD 1.1. See also footnote 1 of AWSD1.1, Table 3.2	

F. Interpass Temperature: Minimum interpass temperatures shall be in accordance with the minimum preheat requirements. Maximum interpass temperatures shall not exceed 550ºF. Inspector shall measure interpass temperatures during the work. Measurement shall be taken on base metal, not more than 2 inches from the weld.

G. Special requirements:

1. Technique: Weld passes shall be made using stringer beads only, weaving passes are not permitted. For multi-pass beam-column flange welds, the first pass shall be placed at the column flange and the welding shall proceed towards the beam flange.

2. Backing Bars: Backing bars, where used, shall be continuous, without butt joints, across the entire width of the joint, including the length of the weld tabs. Unless otherwise noted on the drawings, all backing bars shall be removed by thermal cutting, the root back-gouged, the root and surrounding base metal ground to remove 1/32 inch of surface material, the prepared groove tested for defects using magnetic particle or dye penetrant testing, the groove rewelded and capped with a fillet weld according to the profile indicated on the drawings but not less than 1/4 inch. The weld metal for the backing fillet weld shall be made using the same process and filler metal as the groove weld.

3. Weld Tabs: Weld tabs shall be used for all groove welds, and shall be in accordance with AWS D1.1. Weld tabs shall be removed upon completion of the weld and the ends of the weld shall be made smooth and ground flush with the abutting parts. The detailed transition of weld material to the base metal shall embody a radius not less than the thickness of the beam flange. Except where end of weld is to be NDT tested, grind surface to AWS C4.1-77 Sample 2 roughness, otherwise grind to a smoothness required by the testing technique to be used. "End Dams" or other devices that are placed perpendicular to the weld axis shall not be used.

4. Weld Access Holes: Connection plates at or near the weld access hole shall be sized to ensure the weld access hole region remains unobstructed. Where weld access holes are made by thermal cutting, the surface of the cut and the surrounding base metal shall be ground at least 1/32 inch to bright metal to remove any martensite.

5. Welding through Weld Access Holes: All passes shall begin at the center of the joint and work towards the ends of the joint, terminating on the Weld Tab. Each weld layer shall be completed on both sides of the beam web before the next weld layer is started.

6. Faulty and Defective Welding: Any welding performed without inspection or contrary to the approved WPS, or showing cracks, slag inclusion, lack of fusion, undercut or other defects as defined by AWS, ascertained by visual or other means of inspection, shall be chipped out and properly replaced by the CONTRACTOR, and reinspected by CITY's Testing Agency, at the CONTRACTOR's expense.

3.4 ERECTION

A. Field Connections: Workmanship of field bolted and welded connections shall conform in all respects to methods and tolerances specified for fabrication.

B. High strength bolted connections shall be made in conformance with the "Specification for Structural Joints using ASTM A325 or A490 Bolts" approved by Research Council on Riveted and Bolted Joints of the Engineering Foundation.

C. Furnish and install temporary bracing to provide stability during erection and to prevent distortion or damage to the framing due to wind, seismic, or erection forces. Remove temporary bracing when erection is complete.

D. No final connections shall be made until the structure has been properly aligned. All temporary flooring, planking and scaffolding necessary in connection with the erection of the structural steel, or the support of erection machinery shall be provided as part of the erection work. The temporary floors and scaffolding shall conform to the requirements of all laws governing safety regulations.

E. Drifting done during assembly shall not distort the metal or enlarge the holes. Mismatching of holes greater than 3/32 inch shall require reaming for the next larger bolt. Mismatching of holes greater than 1/8 inch shall be cause for rejection.

F. H-Beam Flashing: 26-gauge stainless steel, two-piece / split flashing. Flashing shall be Model H/D by SBC Industries, or approved equal.

3.5 DEFECTIVE WORK

A. Work found to be defective, missing or damaged shall immediately be replaced with proper work. Such replaced work and the inspection for same shall be at the expense of the CONTRACTOR.

B. Straightening of any material, if necessary, shall be done by a process and in a manner that will not injure the materials, and which is approved by the ENGINEER. Sharp kinks or bends shall be cause for rejection. Heating will not be allowed.

C. Delamination and other rolling defects in structural shapes and plates shall be cause for rejection when, in the judgment of the ENGINEER, repairs are not feasible or acceptable.

D. If defects or damaged work cannot be corrected in the field, the material shall be returned to the shop or new parts furnished, as the ENGINEER directs; the CONTRACTOR shall replace all work at his own expense.

END OF SECTION

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SECTION 05210 – STEEL JOISTS

PART 1 GENERAL

1.1 THE REQUIREMENT

A. Furnish all labor, materials, equipment and incidentals and install steel joists and bridging complete as shown on the Drawings and as specified herein.

B. Provide all brackets, braces and supports required to install joists as shown on the Drawings, at no additional expense to the CITY.

1.2 REFERENCE SPECIFICATIONS, CODES, AND STANDARDS

A. Steel Joist Institute (SJI)

1. Standard Specifications for Open Web Steel Joists, K-Series.

2. Standard Specifications for Joist Girders

B. ASTM International (ASTM)

1. ASTM A325 – Standard Specification for Structural Bolts, Steel, Heat Treated, 120/105 ksi Minimum Tensile Strength

2. ASTM B695 – Standard Specification for Coatings of Zinc Mechanically Deposited on Iron and Steel

C. American Welding Society (AWS)

1. AWS D1.1 – Structural Welding Code - Steel

D. Where reference is made to one of the above standards, the revision in effect at the time of bid opening shall apply.

1.3 CONTRACTOR SUBMITTALS

A. Submit, in accordance with Division 1, shop drawings and product data, showing:

1. Location and size of all members.

2. Materials and details of construction of all members, including camber.

3. Details of installation of all members.

4. Size and length of all field welds to supports.

5. Erection marks. Mark each field piece to correspond to the Shop Drawings.

6. Uniform, concentrated and varying loads used to design the special joists indicated on the Drawings.

B. Product data for shop primer. Certify compatibility with additional coatings specified in Section 09900.

C. Certificates:

1. Certification from the Steel Joist Institute showing that the manufacturer's products conform to the Institute's standards and load tables for the type of member provided.

2. Certification for welders.

D. Shop drawings shall be stamped by a Professional Civil/Structural Engineer registered in the State of California.

E. Submit Structural calculations stamped by a Professional Civil/Structural Engineer registered in the State of California.

1.4 QUALITY ASSURANCE

A. Steel joists, bridging and accessories shall be fabricated in accordance with the standards of the Steel Joist Institute by a manufacturer certified by the Steel Joist Institute. Steel joists shall be of welded construction and top and bottom chords shall be constructed of hot rolled shapes. Rods, reinforcing bars, or cold-formed shapes will not be allowed for top and bottom chords.

B. Field welding shall be done by certified welders in accordance with AWS D1.1.

1.5 DELIVERY STORAGE AND HANDLING

A. Handle material with cranes and derricks. Do not dump joists off cars or trucks, or handle in any way likely to cause damage.

B. Store material on skids and not on the ground. Pile and block stored material to prevent bending or other damage.

C. Materials with excessive damage, in the opinion of the ENGINEER, shall not be incorporated in the work. Remove and replace them with new undamaged materials at no additional cost to the CITY.

PART 2 PRODUCTS

2.1 MATERIALS

A. Open web steel joists shall conform to SJI Standard for Open Web Steel Joists, size and location as shown on the Drawings.

B. Size and location of diagonal and horizontal bridging shall be as shown on the Drawings.

C. Provide top chord extensions, extended ends, deep bearings, and/or sloped bearings where shown on the Drawings.

D. High strength steel bolts shall conform to ASTM A325 and shall be mechanically galvanized in accordance with ASTM B695, Class 50, Type II.

E. Joists shall be fabricated without preset camber.

2.2 SURFACE PREPARATION AND SHOP COATINGS

A. Prepare surfaces and apply shop paint in accordance with Section 09900.

B. The CONTRACTOR shall notify the CITY at least four weeks in advance of surface preparation and painting in the fabricator's shop so that a local independent NACE paint inspector can provide local inspection and dry film testing before the steel leaves the shop. The cost for the independent NACE paint inspector will be paid for by the CITY.

PART 3 EXECUTION

3.1 INSTALLATION

A. Install steel joists in accordance with the Steel Joist Institute standards, approved Shop Drawings and the Drawings. Weld or bolt joists to supports as shown on the Drawings.

B. Weld or bolt bridging to joists and structural steel as shown on the Drawings. Bridging and bridging anchors shall be completely installed before construction loads are placed on the steel joists.

3.2 FIELD PAINTING

A. After erection, prepare shop primed surfaces as approved and touch-up all steel surfaces which have become abraded or where paint has been omitted or removed due to welding or other erection procedure with the shop primer used.

3.3 INSPECTION

A. The ENGINEER reserves the right to inspect joists in the field for compliance with the Steel Joist Institute standards, this Section and the approved shop drawings. The ENGINEER may reject or require repair or refabrication of any joists or accessories not meeting these requirements.

END OF SECTION

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SECTION 05310 – STEEL ROOF DECK

PART 1 GENERAL

1.1 THE REQUIREMENT

A. Furnish all labor, materials, equipment and incidentals required and install steel roof deck complete as shown on the Drawings and as specified herein.

1.2 REFERENCE SPECIFICATIONS, CODES, AND STANDARDS

A. Steel Deck Institute (SDI)

1. SDI Specifications and Commentary for Steel Roof Deck

B. ASTM international (ASTM)

1. ASTM A653 – Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron, Alloy-Coated (Galvannealed) by the Hot-Dip Process

C. American Iron and Steel Institute (AISI)

1. AISI SG-673 – Cold-Formed Steel Design Manual

D. International Code Council (ICC)

1. California Building Code – 2016

E. Where reference is made to one of the above standards, the revision in effect at the time of bid opening shall apply.

1.3 CONTRACTOR SUBMITTALS

A. Submit, in accordance with Division 1, shop drawings and product data, showing:

1. Location and size of all members.

2. Materials, finishes and details of construction of all members.

3. Manufacturer's load table including design thickness in inches and section properties.

4. Fastener types and layout patterns.

5. Erection marks. Mark each bundle to correspond to the shop drawings.

B. Samples:

1. 12”x12” sample of High Density Composite Flooring

C. Certification:

1. Certification from the Steel Deck Institute (SDI) that the steel roof deck is designed in accordance with SDI standards.

D. Warranty: High Density Composite Flooring.

1.4 QUALITY ASSURANCE

A. Steel roof deck shall conform to the requirements of the SDI standard for Steel Roof Deck.

B. Field welding shall be done by certified welders and shall be in accordance with the AISI standard. Welding shall receive special inspection in accordance with Section 1704 of the CBC.

1.5 DELIVERY, STORAGE AND HANDLING

A. Handle material with cranes and derricks. Do not dump materials off cars or trucks, or handle in any way likely to cause damage.

B. Store materials off the ground with one end elevated to provide drainage. Protect from the elements with a waterproof covering, ventilated to avoid condensation.

C. Materials with excessive damage, in the opinion of the ENGINEER, shall not be incorporated in the work. Remove and replace with new undamaged materials at no expense to the CITY.

1.6 WARRANTY

A. Provide the CITY with warranty that high density composite flooring system shall be guaranteed against all the conditions indicated below, for a period of 10-years from the date of Substantial Completion.

1. Defects in materials and workmanship.

2. Deterioration of material and surface performance. Ordinary wear and tear, unusual abuse or neglect excepted.

1.7 PROJECT/SITE REQUIREMENTS

A. Bring inaccuracies in alignment or level of structural steel and steel joists to the attention of the ENGINEER in writing and correct before the deck is placed.

1.8 DEFINITIONS

A. Transverse supports – supports that are perpendicular to the direction of the deck ribs.

B. Longitudinal support – supports that are parallel to the direction of the deck ribs.

PART 2 PRODUCTS

2.1 MATERIALS

A. Steel roof deck shall be 1-1/2-in rib depth, Type B (wide rib) as manufactured by Vulcraft (or approved equal). Deck sheets shall be 36-in wide with interlocking side laps. Gauge shall be as shown on the Drawings.

B. Steel roof deck and accessories shall be manufactured from steel conforming to ASTM A653, Grade A, B, C, D, E or F.

C. Steel roof deck and accessories shall be galvanized in accordance with ASTM A653. Coating designation shall be G90.

D. Provide minimum 18 gauge closure strips, cant strips and butt plates as shown on the Drawings and as specified herein. Provide minimum 14-gauge roof sump pans as shown on the Drawings.

E. High Density Composite Flooring:

1. Fabricated from combination of processed wood fibers and formaldehyde free resins and wax emulsifiers.

2. Minimum of ¾”-thick and capable of supporting live and dead loads up to 2,500 lbs.

3. Basis of Design Product: ResinDek® SD, with Gray Diamond Seal2™.

PART 3 EXECUTION

3.1 INSTALLATION

A. Install steel roof deck as shown on the Drawings, in accordance with manufacturer's instructions and in accordance with approved shop drawings. Where possible, extend deck sheets over three or more spans.

B. End laps of steel roof deck shall be at least 2-in long and shall occur over transverse supporting members.

C. Fasten steel roof deck to all interior and exterior transverse supports and at side laps and longitudinal supports. Deck fasteners and fastener spacing shall be as noted in the Steel Deck Schedule and Roof Deck Fastening Standard Details or as indicated on the Roof Framing Drawing.

D. Maintain contact between deck sheets and deck sheets and steel supports while fastening steel roof deck to reduce burn holes at welded connections.

E. Welds to supporting members at end laps and side laps shall go through both sheets and fuse properly to the supporting steel.

F. Coordinate size, location and details of all penetration with the Drawings, other trades and details of approved equipment. Pipe and conduit openings in the steel roof deck shall be reinforced according to the manufacturer's recommendation.

G. High density composite flooring shall be installed in accordance with manufacturer's written instructions. Deviation from these instructions shall not be permissible.

3.2 CUTTING AND FITTING

A. Cut and fit steel roof deck units and accessories around projections through steel roof deck.

B. Make cuts neat, square and trim.

C. Cut openings in steel roof deck true to dimensions using metal saws, drills or cuttings torches.

D. Do not use cutting torches if neat appearance is required.

E. Openings greater than 6-in and less than 12-in in greatest dimension shall be reinforced with a 24-in by 24-in flat plate, minimum 20-gauge thickness, centered on the opening.

F. Weld closure strips, cant strips, butt plates and roof sump pans directly to steel deck to provide a finished surface.

3.3 ROOF SUMP PANS AND REINFORCING PLATES

A. Place roof sump pans and reinforcing plates over openings in steel roof deck and weld to top surface of steel roof deck.

B. Space welds not more than 6-in on center with at least one weld at each corner.

C. Cut openings in roof sump pan or reinforcing plate to accommodate drain or other fixture.

3.4 CANT STRIPS AND BUTT PLATES

A. Weld to top surface of steel roof deck at no more than 12-in on center.

B. Lap end joints not less than 3-in.

3.5 CLOSURE STRIPS EAVE PLATES

A. Install closure strips at all open uncovered ends and edges of steel roof deck and in voids between deck and other construction.

B. Weld to top surface of steel roof deck at not more than 12-in on center and into position to provide complete deck installation for support of roof insulation.

C. Suspended ceilings, light fixtures, ducts, piping, conduits or other utilities shall not be attached to steel roof deck.

3.6 FIELD PAINTING

A. Touch-Up Field Painting.

B. Clean thoroughly and touch-up all steel surfaces which have become abraded or where galvanizing has been damaged due to welding and/or erection procedures.

C. Paint shall be approved 95 percent zinc dust, organic vehicle primer compatible with the galvanized surfaces.

3.7 INSPECTION

A. The ENGINEER reserves the right to inspect steel roof deck in the field for compliance with the requirements specified herein and the approved shop drawings. The ENGINEER may reject or require repair or refabrication of any steel roof deck or accessories not meeting these requirements at no additional cost to the CITY.

END OF SECTION

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SECTION 05400 – COLD-FORMED METAL FRAMING

PART 1 GENERAL

1.1 THE REQUIREMENT

A. Furnish all labor, materials, equipment and incidentals necessary and construct all light metal framing and appurtenant work, as shown on the Drawings or specified herein.

1.2 REFERENCE SPECIFICATIONS, CODES, AND STANDARDS

A. American Iron and Steel Institute (AISC)

1. Specification for Design of Cold-Formed Steel Structural Members

2. Standard for Cold-Formed Steel Framing – Prescriptive Method for One and Two-Family Dwellings.

B. ASTM International (ASTM)

1. ASTM A570 – Steel, Sheet and Strip, Carbon, Hot-Rolled, Structural Quality

2. ASTM A653 – Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy Coated (Galvanized) by the Hot Dipped Process

3. ASTM A792 – Standard Specification for Steel Sheet, 55% Aluminum-Zinc Alloy-Coated by the Hot-Dip Process

4. ASTM A780 – Practice for Repair of Damaged Hot-Dip Galvanized Coatings

5. ASTM A875 – Standard Specification for Steel Sheet, Zinc-5% Aluminum Alloy-Coated by the Hot-Dip Process

6. ASTM A924 – Standard Specification for General Requirements for Steel Sheet, Metallic-Coated by the Hot-Dip Process

7. ASTM A1003 – Steel Sheet, Carbon Metallic and Non-Metallic Coated for Cold-Formed Framing Members

8. ASTM C645 – Non Structural Steel Framing Members

9. ASTM C954 – Standard Specification for Steel Drill Screws for the Application of Gypsum Panel Products or Metal Plaster Bases to Steel Studs from 0.033 in. (0.84mm) to 0.122 in. (2.84mm) Thickness

10. ASTM C955 – Standard Specification for Load-Bearing (Transverse and Axial) Steel Studs, Runners (Tracks), and Bracing or Bridging for Screw Application of Gypsum Panel Products and Metal Plaster Bases

11. ASTM C1007 – Installation of Load-Bearing (Transverse and Axial) Steel Studs and Related Accessories

C. American Welding Society (AWS)

1. Structural Welding Code, D1.1 – Steel

2. Structural Welding Code, D1.3 – Sheet Steel

D. International Code Council Evaluation Services (ICC-ES).

1. Manufacturer Evaluation Reports, as appropriate.

E. International Association of Plumbing and Mechanical Officials Uniform Evaluation Services (IAPMO-UES)

1. Manufacturer Evaluation Reports, as appropriate.

F. Steel Stud Manufacturers Association (SSMA)

1. Product Technical Information

2. Supplemental Product Technical Information

G. Where reference is made to one of the above standards, the revision in effect at time of bid opening shall apply.

1.3 CONTRACTOR SUBMITTALS

A. Product Data – Submit product information and installation instructions from manufacturer(s) for each item of cold-formed metal framing and accessories.

B. Shop Drawings – Shop drawings shall include placing drawings for framing members, showing size and gauge designations, number, type, location and spacing:

1. Indicate supplemental strapping, bracing, splices, bridging, accessories and details required for proper installation.

2. Indicate fastening and anchorage details, including mechanical fasteners.

C. Weld Certificates – Provide certificate, signed by CONTRACTOR, certifying that welders comply with the requirements of AWS D1.1 and D1.3.

D. Welding Procedures – Provide written Welding Procedure Specification (WPS) document per AWS Code requirements.

1.4 QUALITY ASSURANCE

A. Component Design – Calculate structural properties of studs and joists in accordance with the AISC "Specifications for Design of Cold-Formed Steel Structural Members".

B. Comply with AISI 230, “Standard for Cold Formed Steel Framing – Prescriptive Method for One and Two-Family Dwellings.

C. Single Source Responsibility – Obtain cold-formed metal framing elements from a single manufacturer.

D. Cold-Formed Metal Studs shall have a legible label, stencil, stamp or embossment with the following, minimum, information:

1. Manufacturer's identification

2. Minimum uncoated steel thickness in inches

3. Minimum coating designation

4. Minimum yield strength, in kips-per-square-inch (ksi)

E. Welding Standards – Comply with the applicable provisions of AWS Structural Welding Codes D1.1 and D1.3.

1.5 DELIVERY, HANDLING AND STORAGE

A. All materials shall be delivered promptly so as to cause no delay with other parts of the Work. Deliver materials to project site in manufacturer's unopened containers or bundles, fully identified with name, brand, type, and grade.

B. Stored materials shall be placed on skids and not on the ground and shall be piled and blocked up so that they will not become bent or otherwise damaged.

C. Materials shall be stored inside a well-ventilated area, away from uncured concrete and protected from weather, moisture, soiling, abrasion, extreme temperatures, and humidity.

D. Materials shall not be dumped off cars or trucks nor handled in any other way likely to cause damage. Materials with excessive damage, in the opinion of the ENGINEER, shall not be incorporated into the Work and shall be removed and replaced with new undamaged materials by the CONTRACTOR at no additional expense to the CITY.

PART 2 PRODUCTS

2.1 GENERAL

A. The use of manufacturer's name and model or catalogue number is for the purpose of establishing the standard of quality and general configuration desired.

B. All like materials shall be the product of one manufacturer or supplier in order to provide standardization of appearance.

C. Subject to compliance with requirements, provide The Steel Network, Inc. or comparable products by one of the following:

1. Dietrich Metal Framing

2. MBA Metal Framing

3. Or approved equal.

2.2 COLD-FORMED METAL STUDS

A. Metal Studs shall be used where shown on the Drawings or where specified herein. They shall be standard punched steel, galvanized, formed from steel meeting the requirements specified herein.

B. Runners (Tracks) and erection accessories shall be standard products of an established metal stud manufacturer, unless otherwise specified or shown.

C. Metal Studs shall be cold-formed, shaped from structural quality sheet steel, complying with the requirements of one of the following standards:

1. ASTM A653; Grades 33, 37, 40 and 50 (Classes 1 and 3),

2. ASTM A792; Grades 33, 37, 40 and 50A, or

3. ASTM A875; Grades 33, 37, 40 and 50 (Classes 1 and 3).

D. Metal Studs shall have a metallic coating complying with one of the following standards:

1. ASTM A653, Minimum of G60,

2. ASTM A792; Minimum of AZ50, or

3. ASTM A875; Minimum of GF60

E. Metal Studs shall have minimum thickness complying with the following dimensional requirements:

1. Designated 33; 0.033-inch (Gage 20),

2. Designated 43; 0.043-inch (Gage 18),

3. Designated 54; 0.054-inch (Gage 16), and

4. Designated 68; 0.068-inch (Gage 14).

F. Metal Studs shall conform to the following dimensional requirements:

1. Web depth 3⅝-inches or 6-inches,

2. Minimum flange width – 1⅝-inches.

3. Maximum flange width – 2-inches.

4. Minimum lip size – ½-inch.

G. Connector Devices: For continuous transfer of loads from framing members to foundation, ASTM 653, Grade 50, G90 zinc coated

1. Basis of Design Product:

a. Tie-Down to Foundation: The Steel Network, Inc. StiffClip CL/TD.

b. Header Connector: The Steel Network, Inc. StiffClip HE.

c. Roof Tie Down: The Steel Network, Inc, StiffClip RT.

H. Wall Bridging:

1. Channel Bridging Inside Wall: 1½" web, ¾" flanges, uncoated thickness and G-90 hot-dipped galvanized coating according to ASTM A123.

2. Basis of Design Product: The Steel Network, Inc. BridgeBar BB 150.

I. Bridging Clip: The Steel Network, Inc. BridgeClip BC600, ASTM A653, Grade 50, G-90 zinc coated.

J. Special Solid Backing Support Plates: The Steel Network, Inc. BackIt Rigid Wall Backing Plates. ASTM A653, Grade 50, G90 zinc coating, minimum design thickness of 0.0346 inches.

2.3 FLOOR JOIST FRAMING

A. Steel Joists: Manufacture's standard C-shaped steel joist, of web depths indicated, unpunched with stiffened flanges, and as follows:

1. Minimum Base-Metal Thickness: 0.0428 inches

2. Flange Width: 2½ inches.

B. Steel Joist Track: Manufacturer's standard U-shaped steel joist track, of web depths indicated, unpunched, with unstiffened flanges as follows:

1. Minimum Base Metal Thickness: 0.0428 inches

2. Flange Width: 1½ inches

C. Connector Devises: For transfer of loads from joists framing members, ASTM A653, Grade 50, G90 zinc coating, The Steel Network, Inc. StiffClip JC or JH.

2.4 SHEAR WALL FRAMING

A. Shear Wall: Light gauge straps on both sides of the wall to provide shear resistance.

1. Shear wall dimensions and loading, see plans.

2. Basis of Design Product: The Steel Network, Inc. StiffWall SW-S and Hardy Frame Shear Wall System.

2.5 HEIGHT LIMITS AND SCHEDULE

A. Refer to ICC-ES Evaluation Report 4943P "Bearing and Non-Bearing Steel Studs" for the minimum quality and general configuration desired.

2.6 MISCELLANEOUS MATERIALS

A. Runner Channels – Runner channels shall be 1½-inch cold-rolled channels and ¾-inch stiffener channels, galvanized or factory-coated with rust-inhibitive paint. Channels shall have minimum weight of 475 and 300 lbs/1000 Linear-feet respectively.

B. Furring Channels – Furring channels shall be designed for screw attachment of ⅝-inch gypsum wallboard. They shall be roll-formed, galvanized Grade "A" steel conforming to ANSI/ASTM A 446, with a metal thickness of 0.022-inch minimum, ⅞-inch depth, and 1⅜-inch web.

C. Fasteners – Fasteners shall be as required and as recommended within the Reference Standards.

D. Welding Materials – Welding materials shall be as recommended in the published standards of the structural stud manufacturer.

E. Powder-Driven Pins – Refer to Section 05500, Miscellaneous Metals.

2.7 FABRICATION

A. General – Framing components may be prefabricated into assemblies before erection. Fabricate panels plumb, square, true-to-line, and braced against racking with joints welded. Perform lifting of prefabricated units in a manner that prevents damage or distortion.

1. Fabricate units in jig templates to hold members in proper alignment and position and to assure consistent component placement.

B. Fasten cold-formed metal framing members by welding or screw fastening, as standard with fabricator. Do not field weld units of 20-gauge or lighter. Wire tying of framing members is not permitted.

1. Comply with AWS requirements and procedures for welding, appearance and quality of welds, and methods used in correcting weld work.

2. Locate mechanical fasteners and install according to cold-formed metal framing manufacturer's instructions.

C. Fabrication Tolerances – Fabricate units to a maximum allowable deviation in any plane not greater than 3/16-inch from an 8-foot straight line and ½-inch maximum in a surface having a total length in excess of 8-feet.

PART 3 EXECUTION

3.1 INSTALLATION

A. General – Install cold-formed metal framing and accessories plumb, square, true-to-line, and with connections securely fastened, in accordance with manufacturer's recommendations and the requirements of this Section.

1. Fasten cold-formed metal framing members by welding or screw fastening, as standard with fabricator.

2. Comply with AWS requirements and procedures for welding, appearance and quality of welds, and methods used in correcting weld work.

a. Where weld throat is not shown on the Drawings, the weld throat shall be at least as large as the thickness of the thinnest sheet joined. All welds shall provide complete fusion of the sheets without "blow-out."

b. Locate mechanical fasteners and install according to cold-formed metal framing manufacturer's instructions.

c. Wire tying of framing members is not permitted.

B. Runner Tracks – Install continuous tracks sized to match studs. Align tracks accurately to layout at base and top of studs.

1. Secure tracks as recommended by stud manufacturer for type of construction involved, spacing not to exceed 24-inches on-center for nail or powder-driven fasteners, or 16-inches on-center for other types of attachment. Provide fasteners at corners and ends of tracks.

2. All track butt joints, abutting pieces of track shall be securely anchored to a common structural element or they shall be spliced together.

C. Wall Studs – Secure studs to top and bottom runner tracks, except where provisions for structure's vertical movement is provided on the Drawings, by either welding or screw fastening at both inside and outside flanges. Each stud shall be crimped into runner tracks at the top, bottom, and both sides for friction fit with ¼-inch deflection clearance on top.

1. Set studs plumb, except as needed for diagonal bracing or required for non-plumb walls or warped surfaces and similar requirements.

2. Where stud system abuts structural columns or walls, including masonry walls, anchor ends of stiffeners to supporting structure.

3. Wall Stiffening – Walls shall be stiffened with ¾-inch channels placed horizontally at not more than 4½-foot vertical spacing, minimum of two per wall section.

4. Axially loaded studs shall have full bearing against the inside web of top and bottom tracks. Splices in axially loaded studs are not permitted.

5. Stud Requirements – Metal stud installation shall conform to the following requirements:

a. Studs (16ga minimum) shall be located at all doorframe jambs, at abutting construction, intersecting walls, and corners. Each corner and intersection of walls and partitions shall be formed with not less than three studs.

b. Double studs (16ga minimum) shall be secured to the jamb anchors of each doorframe by bolt or screw attachment. Studs at door openings shall extend to the structure.

c. Studs extending from doorframe header to ceiling runner over doorframes shall be positioned at wallboard joints. Stud walls which do not extend to structures above the ceiling shall be braced to the structure at every 8'-0" on-center.

d. The CONTRACTOR shall install studs (16ga minimum) at wall-mounted fixtures and at a maximum of 12-inches on-center behind walls to receive ceramic tile.

e. Stud walls shall be braced as necessary to provide rigid construction. Double row of studs for chase walls shall be braced with cross ties of ½-inch or ⅝-inch gypsum board, 12-inches wide, installed at quarter points of studs.

6. Openings – Openings shall conform to the following requirements:

a. Channels shall be provided around openings for attachment of metal frames, dampers, grilles, and ductwork in connection with metal studs and shall be securely fastened to studs.

b. Headers, sills, and jack studs shall be provided as required at openings. Headers shall overlap adjacent vertical studs and shall be securely screw-attached to adjacent studs.

c. Where 25-gauge studs are used, a 1½-inch channel stiffener shall be installed 6-inches above the door openings. Stiffeners shall extend past the second single-stud on each side of the opening, and shall be saddle-tied to the structure.

D. Install supplementary framing, blocking, and bracing in metal framing system wherever walls or partitions are indicated to support fixtures, equipment, services, casework, heavy trim and furnishings, and similar work requiring attachment to the all of partition. Where type of supplementary support is not otherwise indicated, comply with stud manufacturer's recommendations.

E. Lintels – Trussed or box-framed lintel members designed to resist applied loads without excessive deflection shall be provided and shall be secured together by screws or other approved means.

F. Support for Wall-Mounted Braced Items – Solid blocking, 1½-inch channels, horizontal studding or other members within walls shall be provided as required to provide secure and adequate support for wall-mounted or wall-braced items. Galvanized plates shall be provided as backing for handrail brackets, minimum of 16-gauge by 8-inch by 16-inch.

G. Horizontal Stiffeners – Ends of horizontal stiffeners shall be securely fastened to abutting construction.

H. Furring Channels – Furring channels shall be spaced 16-inches on centers, maximum, unless shown otherwise. Spans shall not exceed manufacturer's published recommendations and governing code requirements.

3.2 INSTALLATION OF JOISTS

A. Joist shall be installed level, straight, and plumb, complete with bracing and reinforcing as indicated on drawings. Provide not less than 1½-inch end bearing.

1. Reinforce ends with end clips, steel hangers, steel angle clips, steel studs sections, or as otherwise recommended by the manufacturer.

2. When required, reinforce joists at interior supports with single short length of joist section located directly over interior support, snap-on shoe, 30-percent side-piece lapped reinforcement, or other method recommended by joist manufacturer.

3. Secure joists to interior support systems to prevent lateral movement of bottom flange.

3.3 WORKMANSHIP

A. Alignment – All metal studs shall be installed rigid, in-line, level, and plumb and shall be suitable for the application of the intended succeeding contiguous materials. The maximum allowable deviation in any plane shall be 3/16-inch from an 8-foot straight line and ½-inch maximum in a surface having a total length in excess of 8-feet.

B. Component Fit – All framing members and tracks shall meet the following requirements:

1. All framing components shall be cut squarely or on an angle, as in bracing, to fit squarely against abutting members.

2. Tracks shall be securely anchored to the floor and overhead structure or other members.

3. Studs shall be seated squarely in the track with the stud web and flanges abutting the track web, shall be plumbed or aligned, and shall be securely attached to the flanges or web of both the upper and lower tracks.

C. Temporary Bracing – Framing and panels shall be braced as follows:

1. All framing shall be held firmly in position until properly fastened.

2. Prefabricated panels shall be square and braced against racking. Lifting of prefabricated panels shall be done in a manner as to not cause local distortion in any member.

D. Jack Studs – Jack studs shall be provided between all track and windowsills; between window and door headers and top track; at freestanding stair rails; and elsewhere to furnish structural support. Jack studs shall be securely attached to supporting members.

3.4 FIELD PAINTING

A. Where galvanized surfaces are damaged, prepare surfaces and repair in accordance with procedures specified within ASTM A780.

3.5 CLEAN UP

A. At the completion of the light gauge steel framing work, remove all related debris, excess material, scaffolding, tools, equipment and other appurtenances related to the Work, from the site.

END OF SECTION

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SECTION 05500 – MISCELLANEOUS METALS

PART 1 GENERAL

1.1 THE REQUIREMENT

A. Furnish all labor, materials, equipment and incidentals required and install all miscellaneous metal complete as shown on the Drawings and as specified herein.

1.2 REFERENCE SPECIFICATIONS, CODES, AND STANDARDS

A. Federal Specifications:

1. FF-B-575C – Bolts, Hexagonal and Square

2. MIL-G-18015 A (3) – (Ships) Aluminum Planks (6063-T6)

3. MIL-A-907E – Antiseize Thread Compound, High Temperature

B. Aluminum Association (AA):

1. AA-M32C22A41 – M31 - Mechanical Finish, Fine Satin; C22 - Finish, Medium Matte; A41 - Clear Anodic Coating, Class I

C. American Association of State Highway and Transportation Officials (AASHTO):

1. Standard Specifications for Highway Bridges - HS20 Truck Loading

D. American Concrete Institute (ACI):

1. ACI 355.2 – Qualification of Post-Installed Mechanical Anchors in Concrete

2. ACI 355.4 – Qualification of Post-Installed Adhesive Anchors in Concrete

E. American Institute of Steel Construction (AISC):

1. Manual of Steel Construction – Allowable Stress Design

F. American Iron and Steel Institute (AISI):

1. Design of Light Gauge, Cold-Formed Steel Structural Members

G. ASTM International (ASTM):

1. ASTM A36 – Standard Specification for Carbon Structural Steel

2. ASTM A48 – Standard Specification for Gray Iron Castings

3. ASTM A53 – Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated Welded and Seamless

4. ASTM A108 – Standard Specification for Steel Bar, Carbon and Alloy, Cold Finished

5. ASTM A123 – Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products

6. ASTM A125 – Standard Specification Steel Springs, Helical, Heat Treated

7. ASTM A153 –Standard Specification Zinc Coating (Hot-Dip) on Iron and Steel Hardware

8. ASTM A193 – Standard Specification for Alloy Steel and Stainless Steel Bolting Materials for High Temperature or High Pressure Service and other Special Purpose Applications

9. ASTM A194 – Standard Specification for Carbon and Alloy Steel Nuts for Bolts for High Pressure or High Temperature Service, or Both

10. ASTM A276 – Standard Specification for Stainless Steel Bars and Shapes

11. ASTM A307 – Standard Specification for Carbon Steel Bolts and Studs, 60,000 PSI Tensile Strength

12. ASTM A325 – Standard Specification for Structural Bolts, Steel, Heat Treated, 120/105 KSI Minimum Tensile Strength

13. ASTM A384 – Standard Practice for Safeguarding Against Warpage and Distortion During Hot-Dip Galvanizing of Steel Assemblies

14. ASTM A500 – Standard Specification for Cold-Formed Welded and Seamless Carbon Steel Structural Tubing in Rounds and Shapes

15. ASTM A501 – Standard Specification for Hot-Formed Welded and Seamless Carbon Steel Structural Tubing

16. ASTM A536 – Standard Specification for Ductile Iron Castings

17. ASTM A563 – Standard Specification for Carbon and Alloy Steel Nuts

18. ASTM A575 – Standard Specification for Steel Bars, Carbon, Merchant Quality, M-Grades

19. ASTM A786 – Standard Specification for Hot-Rolled Carbon, Low Alloy, High Strength Low Alloy and Alloy Steel Floor Plates

20. ASTM A992 – Standard Specification for Structural Steel Shapes

21. ASTM A1008 – Standard Specification for Steel, Sheet, Cold-Rolled, Carbon, Structural, High-Strength Low-Alloy, High-Strength Low-Alloy with Improved Formability, Solution Hardened, Bake Hardenable

22. ASTM A1011 – Standard Specification for Steel, Sheet and Strip, Hot-Rolled Carbon, Structural, High-Strength Low-Alloy and Ultra-High Strength, and High-Strength Low-Alloy with Improved Formability

23. ASTM B98 – Standard Specification for Copper-Silicon Alloy Rod, Bar, and Shapes

24. ASTM B209 – Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate

25. ASTM B221 – Standard Specification for Aluminum and Aluminum-Alloy Extruded Bars, Rods, Wire, Profiles and Tubes

26. ASTM B429 – Standard Specification for Aluminum-Alloy Extruded Structural Pipe and Tube

27. ASTM B695 – Standard Specification for Coatings of Zinc Mechanically Deposited on Iron and Steel

28. ASTM C633 – Standard Test Method for Adhesion or Cohesion Strength of Thermal Spray Coatings

29. ASTM E140 – Hardness Conversion Tables for Metals

30. ASTM E384 – Micro Hardness of Materials

31. ASTM F593 – Standard Specification for Stainless Steel Bolts, Hex Cap Screws, and Studs

32. ASTM F594 – Standard Specification for Stainless Steel Nuts

33. ASTM F1554 – Standard Specification for Anchor Bolts, Steel, 36, 55, and 105-ksi Yield Strength

H. American Welding Society (AWS)

1. ANSI/AWS D1.1 – Structural Welding Code - Steel

2. ANSI/AWS D1.2 – Structural Welding Code - Aluminum

3. ANSI/AWS QC1 – Qualification and Certification of Welding Inspectors

I. International Code Council Evaluation Services (ICC-ES)

1. Manufacturer Evaluation Reports, as appropriate.

J. International Association of Plumbing and Mechanical Officials Uniform Evaluation Services (IAPMO-UES)

1. Manufacturer Evaluation Reports, as appropriate.

K. National Fire Protection Association (NAFP):

1. NFPA 101 – Life Safety Code

L. National Association of Architectural Metal Manufacturers (NAAMM)

1. Metal Stairs Manual

M. National Association of Corrosion Engineers (NACE)

1. Coating Inspector Program (CIP)

N. Where reference is made to one of the above standards, the revision in effect at the time of bid opening shall apply.

1.3 CONTRACTOR SUBMITTALS

A. Shop Drawings – Shop drawings of all miscellaneous metalwork shall be submitted to the ENGINEER for review in accordance with Division 1.

B. Layout drawings for grating and/or aluminum plank grating shall be submitted showing the direction of span, type, and depth, size and shape of panels, seat angle details, and details of hold-down fasteners. Load and deflection tables shall be submitted for each style and depth of grating/plank grating used.

C. Product data for architectural expansion joint (EREJ) , including but not limited to, product description indicating compliance with specified requirements, and installation instructions.

D. An ICC-ES and/or IAPMO-UES report listing the ultimate load capacity in tension and shear for each size and type of concrete anchor used shall be submitted to the ENGINEER for review. The CONTRACTOR shall submit manufacturer's recommended installation instructions and procedures for all adhesive anchors for ENGINEER's review. Upon review, by ENGINEER, these instructions shall be followed explicitly.

E. No substitution for the indicated adhesive anchors will be considered unless accompanied with ICC-ES and/or IAPMO-UES report verifying strength and material equivalency.

F. Samples:

1. Submit 12 by 12-inch samples of metal grating, aluminum plank grating and cover plates, illustrating surface finish, color, texture, and jointing details.

2. Submit 12-inch-long samples of guardrail and handrail. Submit samples of elbow, tee, wall bracket, escutcheon, end stop, and rail joint connections.

3. Submit one 6-inch sample for each architectural expansion joint.

G. Design Data:

1. Submit calculations or test data demonstrating that the railings will resist the loads specified in the California Building Code at the post spacing provided.

2. Submit manufacturer's load and deflection tables for grating and aluminum plank grating.

H. Test Reports:

1. Submit a certified copy of mill test reports on each steel and aluminum proposed for use showing the physical properties and chemical analysis.

I. Certificates:

1. Submit certification that the railing system is in compliance with OSHA requirements and California Building Code.

1.4 QUALITY ASSURANCE

A. The work of this Section shall be completely coordinated with the work of other Sections. Verify, at the site, both the dimensions and work of other trades adjoining items of work in this Section before fabrication and installation of items herein specified.

B. Furnish to the pertinent trades all items included under this Section that are to be built into the work of other Sections.

C. All welding shall be performed by qualified welders and shall conform to the applicable AWS welding code. Welding of steel shall conform to AWS D1.1 and welding of aluminum shall conform to AWS D1.2.

D. All welding procedures and welder qualification shall be available in the CONTRACTOR's field office for ENGINEER's review.

E. All welding shall be inspected by an CITY-provided inspector qualified in accordance with AWS requirements and approved by the ENGINEER.

F. Unless otherwise directed by the ENGINEER, the CONTRACTOR shall provide the services of an independent, NACE-certified coating inspector. The cost of such work, except as specifically stated otherwise, shall be paid by the CONTRACTOR. All shop-applied coatings shall be inspected by an inspector, qualified in accordance with NACE requirements and approved by the ENGINEER.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Deliver items to be incorporated into the work of other trades in sufficient time to be checked before installation.

B. Items damaged during transit, inadequate storage, improper handling, or corroded shall be repaired, at the CONTRACTOR's expense, to the satisfaction of the ENGINEER before incorporating them into the work.

1.6 PROJECT/SITE REQUIREMENTS

A. Field measurements shall be taken at the site, before fabrication of items, to verify or supplement indicated dimensions and to ensure proper fitting of all items.

PART 2 PRODUCTS

2.1 GENERAL

A. The use of manufacturer's name and model or catalog number is for the purpose of establishing the standard of quality and general configuration desired.

B. Like items of materials shall be the end products of one manufacturer in order to provide standardization for appearance, maintenance, and manufacturer's service.

C. Steel shall be as listed below, unless otherwise noted:

1. Shapes, Plates, Bars: ASTM A36, unless otherwise noted.

2. Wide-flange structural steel shapes: ASTM A992.

3. Pipe, Pipe Columns, Bollards: ASTM A53, Type E or S, Grade B Standard weight unless noted otherwise.

4. Tubes: ASTM A500 Grade B.

5. Corrosion Protection – Unless otherwise indicated, miscellaneous metalwork of fabricated steel that will be used in a corrosive environment and/or will be submerged in water/wastewater shall be coated in accordance with Section 09900 – Painting and Coatings and shall not be galvanized before coating. All other miscellaneous steel metalwork shall be hot-dip galvanized after fabrication as specified herein.

D. Stainless steel shall be as listed below, unless otherwise noted:

1. Exterior – Stainless steel plates, sheets, and structural shapes ASTM A167, Type 316 (Type 316L for welding) stainless steel and shall not be galvanized. Where anaerobic conditions are noted, Type 304 stainless steel shall be used.

2. Interior/Architectural – Stainless steel plates, sheets, and structural shapes ASTM A167, Type 316.

E. Aluminum shall be as listed below, unless otherwise noted:

1. Extruded Pipe ASTM B429, Alloy 6063-T6.

2. Extruded Shapes ASTM B221, Alloy 6061-T6.

3. Sheet and Plate ASTM B209, Alloy 6061-T6.

4. Aluminum in contact with concrete, masonry, wood, porous materials, or dissimilar metals shall have contact surfaces coated in accordance with the Section 09900 – Painting and Coatings.

F. Cast iron shall be as listed below, unless otherwise noted:

1. Iron castings shall conform to the requirements of ASTM A48, Class 50B or better.

G. Bolts, nuts, and washers shall be as listed below, unless otherwise noted:

1. Carbon Steel Bolts and Studs ASTM A307, Grade A (hot-dip galvanized nuts and washers where noted).

2. Carbon Steel Anchor Bolts for Building Anchorage, ASTM F1554 Grade 36, unless otherwise noted (hot-dip galvanized nuts and washers where noted).

3. Stainless Steel Bolts, Nuts, and Washers, ASTM F593 and ASTM F594, Type 316.

4. High-Strength Steel Bolts, Nuts, and Washers, ASTM A325 (mechanically galvanized per ASTM B695, Class 50, where noted).

a. Elevated Temperature, Exposure Type I.

b. General Application, Type I or Type II.

H. Galvanizing shall be ASTM A123, Zinc with 0.04 percent to 0.07 percent nickel added for steels with silicone content between 0.03 percent and 0.22 percent.

I. Galvanizing shall be Hardware ASTM A153, Zinc with 0.04 percent to 0.07 percent nickel added for steels with silicone content between 0.03 percent and 0.22 percent.

2.2 MISCELLANEOUS ALUMINUM

A. All miscellaneous metal work shall be formed true to detail, with clean, straight, sharply defined profiles and smooth surfaces of uniform color and texture and free from defects impairing strength or durability. Holes shall be drilled or punched. Edges shall be smooth and without burrs. Fabricate supplementary pieces necessary to complete each item even if such pieces are not definitively shown or specified.

B. Connections and accessories shall be of sufficient strength to safely withstand the stresses and strains to which they will be subjected. Exposed joints shall be close-fitting and jointed where least conspicuous. Threaded connections shall have the threads concealed where practical. Welded connections shall have continuous welds or intermittent welds as specified or shown. The face of welds shall be dressed flush and smooth. Welding shall be on the unexposed side as much as possible in order to prevent pitting or discoloration of the aluminum exposed surface. Provide holes for temporary field connections and for attachment of the work of other trades.

C. Miscellaneous aluminum items shall include beams, angles, closure angles, grates, hatches, floor plates, stop plates, stair nosing, and any other miscellaneous aluminum called for on the Drawings and not otherwise specified.

D. Angle frames for hatches, beams, grates, etc., shall be complete with welded strap anchors attached.

E. Stair treads for aluminum stairs shall have abrasive nonslip nosing as approved.

F. Aluminum nosing at concrete stairs shall be Alumogrit Treads, Type 116, by Wooster Products, Inc.; similar by Barry Pattern and Foundry Co.; or approved equal. Furnish with wing-type anchors and flat head stainless steel machine screws, 12 inches on-center. Nosing shall also be used at concrete ladder openings. Nosing shall be a single piece for each step extending to within 3 inches at each side of stair or full ladder width. Set nosing flush with stair treads finish at concrete stairs. Furnish treads with heavy-duty protective tape cover.

2.3 MISCELLANEOUS STEEL

A. All miscellaneous metal work shall be formed true to detail, with clean, straight, sharply defined profiles and smooth surfaces of uniform color and texture and free from defects impairing strength or durability. Holes shall be drilled or punched. Edges shall be smooth and without burrs. Fabricate supplementary pieces necessary to complete each item even if such pieces are not definitively shown or specified.

B. Connections and accessories shall be of sufficient strength to safely withstand the stresses and strains to which they will be subjected. Exposed joints shall be close-fitting and jointed where least conspicuous. Threaded connections shall have the threads concealed where practical. Welded connections shall have continuous welds or intermittent welds as specified or shown. The face of welds shall be dressed flush and smooth. Provide holes for temporary field connections and for attachment of the work of other trades.

C. Miscellaneous steel items shall include beams, angles, lintels, metal stairs, support brackets, baseplates for other than structural steel or equipment, closure angles, bridge crane rails, monorail hoist beams, hold-down straps and lugs, door frames, splice plates, sub-framing at roof openings and any other miscellaneous steel called for on the Drawings and not otherwise specified.

D. Steel pipe pieces for sleeves, lifting attachments, and other functions shall be Schedule 40 pipe unless otherwise shown on the Drawings. Wall and floor sleeves of steel pipe shall have welded circumferential steel waterstops at mid-length.

E. All steel finish work shall be thoroughly cleaned, by effective means, of all loose mill scale, rust, and foreign matter and shall be given one shop coat of primer compatible with the finish coat after fabrication but before shipment. Paint shall be omitted within 3 inches of proposed field welds. Paint shall be applied to dry surfaces and shall be thoroughly and evenly spread and well worked into joints and other open spaces.

F. Galvanizing, where required, shall be the hot-dip zinc process after fabrication. Coating shall be not less than 2 ounces per square foot of surface.

2.4 MISCELLANEOUS STAINLESS STEEL

A. All miscellaneous metal work shall be formed true to detail, with clean, straight, sharply defined profiles and smooth surfaces of uniform color and texture and free from defects impairing strength or durability. Holes shall be drilled or punched. Edges shall be smooth and without burrs. Fabricate supplementary pieces necessary to complete each item even if such pieces are not definitively shown or specified.

B. Connections and accessories shall be of sufficient strength to safely withstand the stresses and strains to which they will be subjected. Exposed joints shall be close-fitting and jointed where least conspicuous. Threaded connections shall have the threads concealed where practical. Welded connections shall have continuous welds or intermittent welds as specified or shown. The face of welds shall be dressed flush and smooth. Provide holes for temporary field connections and for attachment of the work of other trades.

C. Miscellaneous stainless steel items shall include beams, angles, bar racks, and any other miscellaneous stainless steel called for on the Drawings and not otherwise specified.

2.5 MISCELLANEOUS FRAMING AND SUPPORTS

A. Provide miscellaneous metal framing, supports, and other metal items required, including framing for architectural infill panels that are not a part of the structural steel framework but are required to complete the work.

B. Fabricate miscellaneous units to the sizes, shapes, and profiles shown or, if not shown, of the required dimensions to receive adjacent grating, plates, tanks, doors, or other work to be retained by the framing. Except as otherwise shown, fabricate from structural shapes, plates, and bars, of all welded construction using mitered corners, welded brackets, and splice plates and a minimum number of joints for field connection. Cut, drill, and tap units to receive hardware and similar items to be anchored to the Work.

C. Equip units with integrally welded anchors for casting into concrete. Furnished inserts for units must be installed after concrete is placed.

D. Except as otherwise shown, space anchors, 24 inches on-center, and provide units equivalent of 1 1/4-inch by 1 1/4-inch by 8-inch strips.

E. Galvanize all miscellaneous framing and supports.

2.6 FRAMING SUPPORT SYSTEMS FOR PIPE ASSEMBLIES, ANALYZERS, AND APPURTENANCES

A. Provide framing support systems for pipe assemblies shown on the Contract Drawings.

B. Furnish and install all anchoring and connecting hardware required for assembly and installation of the framing support system(s).

C. All anchoring and connecting hardware shall be Type 316 Stainless Steel.

D. All exterior framing support systems, and all systems within sub-grade vaults, for pipe assemblies and appurtenances shall be fabricated of Type 316 Stainless Steel.

E. All framing support systems that are used in interior, non-submerged applications shall be fabricated of low-carbon steel and furnished with a factory-applied, hot-dipped, galvanized coating.

F. Where framing support systems are shown in locations with no adjacent wall, the framing support system shall be free-standing and designed to withstand a point load of 200 pounds applied at the top of the framing system such that the maximum deflection shall not exceed 1/4 inch. Base support members shall be a minimum of 2 feet long and shall use Unistrut P2348 connectors, or approved equal.

G. Manufacturer – Unless otherwise shown, all members shall be P1000, manufactured by Unistrut, or approved equal, with type "HS" hole pattern.

2.7 METAL GRATING

A. General: Metal grating shall be of the design, sizes, and types indicated. Grating shall be completely banded at all edges and cutouts using material and cross section equivalent to the bearing bars. Such banding shall be welded to each cut bearing bar. Support members shall support grating on all sides of an opening. Where grating is supported on concrete, embedded support angles matching grating material shall be used on all sides, unless shown otherwise. Such angles shall be mitered and welded at corners.

B. All pieces of grating shall be securely fastened in two locations to each support. Grating clips, fasteners, anchors, bolts, nuts, and washers for grating and supports shall be Type 316 Stainless Steel.

C. Where grating forms the landing at the top of a stairway, the edge of the grating that forms the top riser shall have an integral, nonslip nosing, with width equal to that of the stairway.

D. Where grating depth is not given, grating shall be provided that will be within allowable stress levels, and that shall not exceed a deflection of 1/4 inch or the span divided by 180, whichever is less. For standard duty, plank, and safety grating, the loading to be used for determining stresses and deflections shall be the uniform live load of the adjacent floor or 100 pounds per square foot (psf), whichever is greater, or a concentrated load of 1,000 pounds. For heavy duty grating, the loading used for determining stresses and deflections shall be AASHTO HS-20.

E. At a minimum, grating bars shall be I-bar configuration and be spaced at 1-3/16 inches on-center. Crossbars shall be spaced at 4 inches on-center, unless otherwise noted.

F. Grating cross bars shall be attached to the bearing bars with interlocked swaged joints having no exposed welding.

G. Openings 2 inches or greater in diameter/dimension and grating edges shall be banded with a bar of the same depth and thickness as the bearing bars. Cut bearing or cross bars shall be welded to the banding bar.

H. Unless otherwise designated by the ENGINEER, the maximum weight of each grating section shall be 80-pounds.

I. Material:

1. Except where indicated otherwise, bar grating shall be fabricated entirely of aluminum, Alloy 6063-T6.

2. Grating that may be partially or wholly submerged shall be fabricated entirely of stainless steel, Type 316.

3. Grating frames, anchors, and supports shall be all aluminum construction, fabricated from aluminum alloy 6061-T6 or as specified on the drawings.

J. Standard Duty Grating:

1. No single piece of grating shall weigh more than 80 pounds, unless indicated otherwise. Standard duty grating shall be serrated bar grating.

2. Crossbars shall be welded or mechanically locked tightly into position so that there is no movement allowed between bearing and cross bars.

K. Safety Grating:

1. Safety grating shall be made of sheet metal punched into an open serrated diamond pattern and formed into plank sections. The open diamond shapes shall be approximately 1-7/8 inch by 11/16 inch in size. Safety grating shall be Grip Strut by G.S. Metals, Safe-T-Grid by IKG Industries, or approved equal.

2.8 ALUMINUM PLANK GRATING

A. General: Aluminum Plank Grating (plank) shall be of the design, sizes, and types indicated in the Drawings or specified herein. Support members shall support plank on all sides of an opening. Where plank is supported on concrete, embedded support angles matching plank material shall be used on all sides, unless shown otherwise. Such angles shall be mitered and welded at corners.

B. Unless otherwise noted, punched plank shall consist of 3 x 19/32-inch rectangular openings, 1 1/2 inches center-to-center and with raised transverse ribs for stiffness.

C. Planks shall be provided with a skid resistance surface, SlipNot® (or approved equal) surface treatment applied for added slip resistance.

D. Unpunched plank shall be provided with recessed lift handles.

E. All pieces of plank shall be securely fastened in two locations to each support. Tread plate, fasteners, anchors, bolts, nuts, and washers for supports shall be Type 316 Stainless Steel.

F. Where plank depth is not given, tread plate shall be provided that will be within allowable stress levels, and that shall not exceed a deflection of 1/4 inch or the span divided by 180, whichever is less. For standard duty tread plate shall be the uniform live load of the adjacent floor or 100 psf, whichever is greater or a concentrated load of 1,000 pounds.

G. Unless otherwise designated by the ENGINEER, the maximum weight of each plank grating shall be 80 pounds.

H. Material:

1. Except where indicated otherwise, plank shall be fabricated entirely of aluminum, Alloy 6063-T6.

2. Plank that may be partially or wholly submerged shall be fabricated entirely of stainless steel, Type 316.

3. Plank frames, anchors, and supports shall be all aluminum construction, fabricated from aluminum alloy 6063-T6 or as specified on the Drawings.

I. Heavy Duty Plank Grating:

1. Unless otherwise designated by the ENGINEER, no single piece of plank shall weigh more than 80 pounds. Heavy duty plank shall be fabricated by Ohio Gratings, Incorporated, or approved equal.

2.9 CHECKERED PLATE

A. Checkered plate shall be not less than 1/4 inch thick (3/8-inch plate thickness for aluminum), and shall have a pattern of raised lugs on one face and shall be smooth on the opposite face. Lugs shall be a minimum of 1 inch in length and raised a minimum of 0.050 inch above the surface. The lugs shall be located in a pattern in which the lugs are oriented at 90 degrees from the adjacent lugs in two orthogonal directions. The rows of lugs shall be oriented at 45 degrees from the edges of the plates.

B. Where no plate material is indicated on the drawings, aluminum alloy 6061-T6 shall be provided. Unless noted otherwise on the drawings, the minimum plate thickness shall be as required to limit deflection, resulting from the greater of the uniform live load of the adjacent floor or a live load of 100 psf, to 1/4 inch or the span divided by 240, whichever is less.

C. Cover plate fastening devices and hardware shall be Type 316 Stainless Steel.

D. Checkered plate shall have a Mill Finish.

2.10 FLOOR HATCHES

A. Where access hatches are called for on the drawings to be mounted on a floor slab (including top slabs that are not covered with a roofing membrane) or on a concrete curb, the hatch shall be a flush type as indicated herein.

B. All hatches shall be fabricated from Aluminum 6061 T6 unless otherwise indicated. All hatch hardware shall be Type 316 stainless steel. Hatches shall be gutter-type, Bilco Type "J" or "JD," Babcock-Davis type "B-FGA," or approved equal, or as shown.

C. Design Live Loads:

1. Where located within a structure, the design loading shall match that required for the adjacent floor area, or, if no loading is given, a minimum of 300 psf, unless indicated otherwise.

2. Exterior covers and grates shall be designed for AASHTO HS20 loading unless indicated otherwise.

D. Hatch Opening:

1. Sizes, number and direction of swing of door leaves, and locations, shall be as indicated on the Drawings. Sizes given shall be for the clear opening. Where the number of leaves is not given, openings larger than 42 inches in either direction shall have double-leaf doors.

2. Unless indicated otherwise, hinges shall be located on the longer dimension side.

3. Unless indicated otherwise, ladder hatches shall be a minimum of 30 inches wide by 36 inches long, with the ladder centered on the shorter dimension, and the door hinge opposite the ladder.

E. Door leaves shall be a minimum of 1/4-inch checkered pattern plate. Channel frames shall be a minimum of 1/4-inch material with an anchor flange around the perimeter.

1. Hatches shall be provided with an automatic hold-open arm with release handle. Hatches shall be designed for easy opening by one person from both inside and outside and shall be balanced to require no more than 30 pounds of opening force (lift–assist). Compression spring operators enclosed in telescoping tubes shall be provided for smooth, easy, and controlled door operation throughout the entire arc of opening and closing.

2. Hatches shall be designed to be watertight and shall be equipped with a joint gutter and moat-type edge drain. A 1 1/2-inch-diameter (minimum) drain connection shall be provided and located by the manufacturer.

3. Hatches shall include a recessed hasp for a padlock that is covered by a hinged lid flush with the surface.

2.11 IRON CASTINGS

A. Iron castings shall be of uniform quality, free from blowholes, porosity, hard spots, shrinkage, distortion, or other defects. They shall be smooth and well cleaned by shot blasting.

B. Covers and grates shall fit together evenly, so that the cover fits flush with the surrounding finish surface and so that the cover does not rock or rattle when loading is applied. Round covers and frames shall have machined bearing surfaces.

C. Covers and grates with matching frames shall be designed to support the following loadings:

1. Where located within a structure, the design loading shall match that required for the adjacent floor area, or, if no loading is given, a minimum of 300 psf, unless indicated otherwise.

2. Exterior covers and grates shall be designed for AASHTO HS20 loading unless indicated otherwise.

2.12 ARCHITECTURAL EXPANSION JOINTS (EREJ)

A. General: Architectural expansion joints (EREJ) shall be of the design, sizes, and types indicated in the Drawings or specified herein.

B. Joint cover system shall allow unrestrained movement of joint without disengagement of cover.

C. Architectural expansion joint shall be provided that will be within allowable stress levels, and that shall not exceed a deflection of 1/4 inch or the span divided by 180, whichever is less. Design shall be based on uniform live load of the adjacent floor or 100 psf, whichever is greater or a concentrated load of 1,000 pounds.

D. Material:

1. Except where indicated otherwise, architectural expansion joint shall be fabricated entirely of aluminum:

a. Extrusions, Alloy 6063-T5.

b. Plates, 6061-T6

c. Sheet, 5052-H32

2. Finish for exposed aluminum components: Mill finish

E. Manufacturer: Furnish assemblies from one manufacturer with a minimum of five years experience in the design and fabrication of architectural expansion joints.

1. Model LASB / 8”-24” *Floor-to-Floor / Seismic Recess Mount* by MM Systems Corporation, Georgia

2. Approved equal.

F. Installer: Firm with a minimum of five-years-experience in installation of systems similar to that required and acceptable to the manufacturer.

G. Fabrication:

1. Fabricate units in single length without intermediate joints.

2. Aluminum protection: Treat surfaces in contact with concrete with factory applied chromate conversion coating for corrosion resistance.

H. Install architectural expansion joint assemblies in accordance with approved shop drawings and manufacturer’s product data. Cover and protect expansion joint cover assemblies from construction traffic.

2.13 STEEL PROTECTION POSTS (BOLLARDS)

A. Provide 4-inch-diameter, Schedule 40 steel pipe, 4 feet above grade, 3 feet 6 inches below grade.

2.14 FALL PREVENTION SYSTEM

A. The fall prevention system shall be the RTC-2000 Climb Rite, as manufactured by Sellstrom; Saf-T-Climb, as manufactured by North Products, Inc.; or approved equal. All necessary components shall be provided, including two safety belts for each fall prevention installation to provide a complete and fully operational fall prevention system. A rail extension shall be provided for each installation. At all locations where fall prevention systems are installed, a safety chain with a snap hook shall be permanently attached to the top of the ladder. The chain shall be long enough to allow a person to connect the belt to the chain while standing on the landing adjacent to the ladder. The chain and snap hook shall have a minimum allowable capacity of 500 pounds. Safety belts shall fit a waist range from 23 inches to 54 inches. Safety rails and associated accessories shall match the ladder material. Fiberglass ladders shall have stainless steel safety rails and accessories

2.15 BOLTS AND ANCHORS

A. Standard Service (Non-Corrosive Application): Unless otherwise indicated, bolts, anchor bolts, washers, and nuts shall be steel, galvanized after fabrication as indicated herein. Threads on galvanized bolts and nuts shall be formed with suitable taps and dies such that they retain their normal clearance after hot-dip galvanizing. Except as otherwise indicated, steel for bolts, anchor bolts, and cap screws shall be in accordance with the requirements of ASTM A307, Grade A.

B. Corrosive Service: All bolts, nuts, and washers in the locations listed below shall be stainless steel as indicated below.

1. All buried locations

2. All submerged locations

3. All locations subject to seasonal or occasional flooding

4. Inside hydraulic structures below the top of the structure

5. Inside buried vaults, manholes, and structures that do not drain through a gravity sewer or to a sump with a pump

6. All chemical handling areas

7. Inside trenches, containment walls, and curbed areas

8. All post-install anchors NOT installed in dry, interior locations

9. Locations indicated on the Contract Documents or designated by the ENGINEER to be provided with stainless steel bolts

C. All bolted connections for aluminum members shall be stainless steel.

D. Unless otherwise indicated, stainless steel bolts, anchor bolts, nuts, and washers shall be Type 316 stainless steel, class 2, conforming to ASTM A276. All threads on stainless steel bolts shall be protected with an antiseize lubricant suitable for submerged stainless steel bolts, to meet government specification MIL-A-907E. Buried bolts in poorly drained soil shall be coated the same as the buried pipe.

1. Antiseize lubricant shall be classified as acceptable for potable water use by the NSF.

2. Antiseize lubricant shall be "PURE WHITE" by Anti-Seize Technology, Franklin Park, IL; or approved equal.

E. Bolt Requirements:

1. The bolt and nut material shall be free-cutting steel.

2. The nuts shall be capable of developing the full strength of the bolts. Threads shall be Coarse Thread Series conforming to the requirements of the American Standard for Screw Threads. All bolts and cap screws shall have hexagon heads and nuts shall be Heavy Hexagon Series.

3. All bolts and nuts shall be installed with washers fabricated of material matching the base material of bolts, except that hardened washers for high strength bolts shall conform to the requirements of the AISC Specification. Lock washers shall be installed with washers where indicated and shall be fabricated of material matching the bolts.

4. The length of all bolts shall be such that after joints are made up, each bolt shall extend through the entire nut, but in no case more than 1/2 inch beyond the nut.

F. Cast-in-Place Anchor Bolts – Unless otherwise indicated, the embedded end of the anchor bolt shall be either headed or with nut and washer. Threaded dimensions for cast-in headed studs and/or headed bolts, before zinc coating, shall conform to the requirements of ANSI/ASME B1.1 having Class 2A tolerances (ANSI/ASME Standard B1.13M Grade 6g). Use of hooked bolts (J-bolts and L-bolts) in lieu of headed studs/bolts is not permissible.

1. Equipment subject to vibration (e.g., pumps, motors, generators, etc.) shall be anchored by means of cast-in-place anchor bolts. Anchor bolt layout shall be by means of a template obtained from the equipment manufacturer or supplier.

G. Adhesive Anchors – Unless otherwise indicated, all adhesive anchors for installation in concrete shall have satisfied the requirements of the Simulated Seismic Tests of ACI 355.4. No substitutions will be considered unless accompanied with ICC-ES report verifying strength and material equivalency and compliance with ACI 355.4.

1. Adhesive anchors shall be Hilti HIT-RE 500-SD adhesive anchors, Simpson SET-XP epoxy adhesive anchors, or approved equal.

2. Adhesive anchors shall not be used for overhead installations (i.e. installations at the underside of concrete slabs).

H. Expansion (Wedge) Anchors – Unless otherwise indicated all expansion anchors for installation in concrete shall have satisfied the requirements of the Simulated Seismic Tests of ACI 355.2. Expansion Anchors shall be zinc-plated carbon steel wedge-type anchors complete with nuts and washers. Type 316 stainless steel, wedge type anchors shall be used where they will be submerged or exposed to the weather or where stainless steel wedge type anchors are required. When the length or embedment of the bolt is not noted on the Drawings, provide length sufficient to place the wedge and expansion sleeve portion of the bolt at least 1 inch behind the concrete reinforcing steel.

1. Expansion anchors shall be Hilti Kwik Bolt TZ anchors, Simpson Strong-Bolt Wedge anchors, or approved equal.

2. Lead caulking anchors will not be permitted.

3. Expansion type anchors shall not be used with equipment subject to vibration (e.g., pumps, motors, etc.).

2.16 POWDER DRIVEN PINS (PDA)

A. Powder-driven pins for installation in concrete or steel shall be heat-treated steel alloy. If the pins are not inherently sufficiently corrosion-resistant for the conditions to which they are to be exposed, they shall be protected in an acceptable manner. Pins shall have capped or threaded heads capable of transmitting the loads the shanks are required to support. Pins that are connected to steel shall have longitudinal serrations around the circumference of the shank.

2.17 IMPACT ANCHOR

A. Impact anchors shall be expansion-type anchors in which a nail-type pin is driven to produce the expansive force. It shall have a zinc sleeve with a mushroom-style head and stainless steel nail pin. Anchors shall be Metal Hit Anchors, manufactured by Hilti, Inc.; Zamac Nailin, manufactured by the Powers Fasteners; or approved equal.

PART 3 EXECUTION

3.1 FABRICATION AND INSTALLATION REQUIREMENTS

A. Fabrication and Erection: Except as otherwise indicated, the fabrication and erection of structural steel shall conform to the requirements of the AISC "Manual of Steel Construction."

B. All steel surfaces that come into contact with exposed concrete shall receive a protective coating of an approved heavy bitumastic troweling mastic applied in accordance with the manufacturer's instructions before installation.

C. Where aluminum contacts a dissimilar metal, apply a heavy brush coat of zinc-chromate primer followed by two coats of aluminum metal and masonry paint to the dissimilar metal.

D. Where aluminum contacts concrete/masonry, apply one coat of TT-P-645B zinc-molybdate primer or a heavy coat of approved alkali resistant bituminous paint to the aluminum or concrete/masonry.

E. Aluminum Railings:

1. Craftsmen experienced in the fabrication of architectural metalwork shall perform aluminum railing fabrication and installation.

2. Exposed surfaces shall be free from defects or other surface blemishes.

3. Dimensions and conditions shall be verified in the field.

4. All joints, junctions, miters, and butting sections shall be precision fitted with no gaps occurring between sections, and with all surfaces flush and aligned.

5. Electrolysis protection of materials shall be provided.

6. Between aluminum grating, aluminum tread plate, aluminum stair treads, or aluminum handrail brackets and steel supports, insert 1/4-inch-thick neoprene isolator pads, 85 plus or minus 5 Shore-A-Durometer, sized for full width and length of bracket or support.

F. Floor Hatches: Unless otherwise shown, the CONTRACTOR shall furnish and install a 1 1/2-inch drain line to the nearest floor drain for all floor hatches.

G. Powder-Driven Pins: Powder-driven pins shall be installed by a craftsman who is certified by the manufacturer as being qualified to install the manufacturer's pins. Pins shall be driven in one initial movement by an instantaneous force that has been carefully selected to attain the required penetration. Driven pins shall conform to the following requirements where "D" = Pin's shank diameter:

Material Penetrated by Pin	Material's Minimum Thickness	Pin's Shank Penetration in Supporting Material	Minimum Space from Pin's CL to Edge of Penetrated Material	Minimum Pin Spacing
Concrete	16D	6D Minimum	14D	20D
Steel	1/4 inch	Steel Thickness	4D	7D

3.2 WELDING

A. Method – All welding shall be by the metal-arc method or gas-shielded arc method as described in the AWS 's "Welding Handbook" as supplemented by other pertinent standards of the AWS. Qualification of welders shall be in accordance with the AWS Standards governing same.

B. Welding electrodes shall meet the minimum requirements of E70XX. Filler metal for welds in moment connections shall have a minimum CVN value of 20 foot-pounds at 0 degrees F.

C. Quality – In assembly and during welding, the component parts shall be adequately clamped, supported, and restrained to minimize distortion and for control of dimensions. Weld reinforcement shall be as indicated by the AWS Code. Upon completion of welding, all weld splatter, flux, slag, and burrs left by attachments shall be removed. Welds shall be repaired to produce a workmanlike appearance, with uniform weld contours and dimensions. All sharp corners of material that is to be painted or coated shall be ground to a minimum of 1/32 inch on the flat.

3.3 GALVANIZING

A. All structural steel plates shapes, bars, and fabricated assemblies required to be galvanized shall, after the steel has been thoroughly cleaned of rust and scale, be galvanized in accordance with the requirements of ASTM A123, except that the weight of zinc coating shall average not less than 1.2 ounce per-square-foot of actual surface area with no individual specimen having a coating weight les than 1.0 ounce per-square-foot. The galvanizing process shall be performed in strict accordance with the requirements of ASTM A384, any galvanized part(s) that become warped as a result of the galvanizing process and/or handling shall be straightened or replaced at no additional expense to the CITY.

B. Bolts, anchor bolts, nuts, and similar threaded fasteners, after being properly cleaned, shall be galvanized in accordance with the requirements of ASTM A153.

C. Repair of Damaged Coating:

1. The maximum area that shall be repaired shall comply with applicable sections of ASTM A123.

2. Repair areas by one of the approved methods in accordance with ASTM A780 whenever damage width exceeds 3/16 inch. Minimum thickness requirements for the repair shall be as described in ASTM A123.

3. Field repairs to galvanizing shall be made using “Galvinox,” “Galvo-Weld,” or approved equal.

3.4 DRILLED ANCHORS

A. Drilled anchors and reinforcing bars shall be installed in strict accordance with the manufacturer's instructions.

B. Holes shall be roughened with a brush on a power drill, cleaned, and dry.

C. Drilled anchors shall not be installed until the concrete has reached the specified 28-day compressive strength. Additionally, concrete shall have a minimum age of 21 days before adhesive anchors and dowels can be installed.

D. Adhesive anchors shall not be loaded until the adhesive has reached its indicated strength in accordance with the manufacturer's instructions.

E. Expansion anchors shall be checked for tightness a minimum of 24 hours after initial installation. Install anchors using the manufacturer's recommended drive units and adapters and in compliance with the manufacturer's recommendations.

3.5 FALL PREVENTION SYSTEM

A. Fall prevention systems shall be provided on all ladders used to ascend heights exceeding 20 feet.

END OF SECTION

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SECTION 05510 – METAL STAIRS AND PLATFORMS

PART 1 GENERAL

1.1 THE REQUIREMENT

A. Furnish all labor, materials, equipment and incidentals necessary and install aluminum stairs complete with anchors and brackets, including integral handrails and posts when applicable, as shown on the Drawings and as specified herein.

1.2 REFERENCE SPECIFICATIONS, CODES, AND STANDARDS

A. ASTM International (ASTM):

1. ASTM B221 – Standard Specification for Aluminum and Aluminum Alloy Extruded Bars, Rods, Wire, Profiles, and Tubes.

2. ASTM E985 – Standard Specification for Permanent Metal Railing Systems and Rails for Buildings.

B. American Institute for Steel Construction (AISC):

1. AISC S326-1978 (Supplement No.1 - 1986) – Specification for the Design, Fabrication, and Erection of Structural Steel for Buildings.

C. Aluminum Association (AA):

1. Specifications for Aluminum Structures.

2. AA 6061-T6 – Aluminum Sheet and Plates.

D. American Welding Society (AWS):

1. AWS D1.1 – Structural Welding Code Steel.

E. American National Standards Institute (ANSI):

1. ANSI A202.1 – Metal Bar Grating Manual for Steel and Aluminum Gratings and Stair Treads.

F. National Association of Architectural Metal Manufacturers (NAAMM):

1. NAAMM AMP 510 – Metal Stairs Manual.

G. Occupational Safety and Health Standards (OSHA)

H. Where reference is made to one of the above standards, the revision in effect at the time of bid opening shall apply.

1.3 CONTRACTOR SUBMITTALS

A. Submit manufacturer's shop drawings, in accordance with Division 1, Shop Drawing Procedures, showing dimensions, material lists, methods of supporting, methods of anchoring and finishes.

B. Product data for manufacturer's product lines of Pre-fabricated Aluminum Stairs assembled from standard components. Submit product data for grout, anchoring cement, and paint products.

C. Shop drawings showing fabrication and installation of Pre-fabricated Aluminum Stairs including plans, elevations, sections, details of components, and attachments to other units of Work.

D. Samples for verification of each type of exposed finish required, prepared on components of same thickness and metal indicated for final unit of Work. Where finishes involve normal color and texture variations, include sample sets showing the full range of variations expected.

E. Qualification data for firms and persons specified in the "Quality Assurance" Article to demonstrate their capabilities and experience. Include lists of completed projects with project names and addresses, names and addresses of architects and owners, and other information specified.

F. Furnish to the ENGINEER a letter signed and sealed by a Civil/Structural Engineer licensed in the State of California that the stair design conforms to the design criteria set forth by the ENGINEER.

G. Submit to the ENGINEER data showing the location, magnitude and direction of all dead and live load reactions imposed on the structure by the stair and railing system.

H. Furnish to the ENGINEER Manufacturer's certification that materials meet specification requirements.

1.4 QUALITY ASSURANCE

A. Single-Source Responsibility – Obtain Pre-fabricated Aluminum Stairs from a single manufacturer.

B. Engineer Qualifications – A professional engineer legally authorized to practice in the jurisdiction where Project is located and experienced in providing engineering services of the kind indicated that have resulted in the installation of similar stairs to this Project in material, design, and extent and that have a record of successful in-service performance.

C. Industry Standards – Comply with the provisions of the following standards and specifications:

1. AISC S326

2. NAAMM – AMP-510

3. AWS-D1.1

1.5 PERFORMANCE REQUIREMENTS

A. General – Pre-fabricated Aluminum Stairs shall be designed to withstand structural loads indicated, determine allowable design working stresses based on Aluminum Association (AA) "Specifications for Aluminum Structures."

B. Structural Performance of Pre-fabricated Aluminum Stairs: Engineer, fabricate, and install to comply with requirements of ASTM E985 for structural performance based on structural computations.

C. Thermal Movements – Allow for thermal movement resulting from the following maximum change (range) in ambient temperature in engineering, fabricating, and installation to prevent buckling, opening of joints, overstressing of components and connections, and other detrimental effects. Base engineering calculation on actual surface temperatures of materials due to both solar heat gain and nighttime sky heat loss.

D. Temperature Change (Range): Allowance for thermal movement shall be based on a temperature change of plus and minus 90 degrees F from the average ambient temperature at the project site, or from the temperature at time of installation, whichever is more stringent.

E. Control of Corrosion – Prevent galvanic action and other forms of corrosion by insulating metals and other materials from direct contact with incompatible materials.

1.6 DELIVERY, STORAGE AND HANDLING

A. All materials shall be delivered promptly so as to cause no delay with other parts of the work. Stored materials shall be placed on skids and not on the ground and shall be piled and blocked up so that they will not become bent or otherwise damaged. Materials shall be stored inside a well-ventilated area, away from uncured concrete and protected from weather, moisture, soiling, abrasion, extreme temperatures, and humidity. Materials shall be handled with cranes or derricks as far as practicable. Material shall not be dumped off cars or trucks nor handled in any other way likely to cause damage. Materials with excessive damage, in the opinion of the ENGINEER, shall not be incorporated in the work and shall be removed and replaced with new undamaged materials by the CONTRACTOR at no expense to the CITY.

PART 2 PRODUCTS

2.1 GENERAL

A. The use of manufacturer's name and model or catalog number is for the purpose of establishing the standard of quality and general configuration desired.

B. All like materials shall be the products of one manufacturer or supplier in order to provide standardization of appearance.

2.2 MATERIALS

A. Aluminum: ASTM B221, Alloy 6061-T6, Finish AA-C22A31.

B. Components:

1. Stringers – Aluminum
2. Headers – Aluminum
3. Treads – Aluminum
4. Risers – Aluminum
5. Platforms – Aluminum
6. Railings – Aluminum

2.3 HANDRAILS–ALUMINUM

A. Size members as required by design calculations and to conform to layout details shown. Detail stair risers, treads and landings to conform to the requirements of the current edition of OSHA.

B. Fabricate stairs, landings and component connections to support a minimum live load of 100-psf with deflection of stairs and landings not to exceed L/360. Stairs exceeding vertical height of 12-ft. shall have intermediate landings.

C. Fabricate railing supports and component connections capable of resisting a lateral force of 200-lbs at any single point, without permanent set or damage.

D. Fabricate stair with risers and treads using structural aluminum channels, angles, plates and extrusions for stringers, treads and all supports. Provide closures for exposed ends of stringers.

E. Fabricate treads from extruded/cast structural aluminum grating with integral nosing to form a one-piece structural unit.

F. Fabricate landings from extruded/cast structural aluminum grating with integral nosing to form a one-piece structural unit. Construct with perimeter structural aluminum channels as shown, side-supported headers and miscellaneous framing members framing into the stair stringers. Reinforce underside of landings.

G. Construct stairs to conform to sizes and arrangements indicated; join pieces together by welding wherever possible. Weld assemblies in accordance with recommendations of AWS. Grind all exposed welds to a match and blend with adjoining surfaces.

H. Provide complete stair assemblies including framing, columns, railings, struts, clips, brackets, bearing plates and all other components necessary for the support of stairs and landings and as required to anchor and contain the stairs on the supporting structure.

I. Shop assemble sections in largest sizes practical, easily maneuverable through building openings.

J. Form work true to line and level with accurate angles and surfaces and straight sharp edges. Ease exposed edges to radius of approximately 1/32-in. Form bent metal corners to smallest radius possible without causing grain separation or otherwise impairing work.

PART 3 EXECUTION

3.1 ERECTION

A. Erect stairs square, level, plumb and free from distortion or defects detrimental to appearance and performance.

B. Provide necessary anchors, plates, angles, hangers and struts as required for connecting stairs to the structure.

C. Ensure alignment with adjacent construction. Coordinate with related work to ensure no interruption in installation.

D. Perform necessary cutting and altering for the installation of work of other Sections. Do not perform any other additional cutting without review of the ENGINEER.

E. Field bolt and weld to match standard of shop bolting and welding. Hide bolts and screws whenever possible. Where not hidden, use flush countersunk fastenings, unless indicated otherwise. Make mechanically fastened joints flush hairline butted. Grind welds smooth and flush.

3.2 PROTECTION

A. Protect aluminum fabrications from damage due to work of adjacent trades.

3.3 CLEANING

A. As work progresses, remove debris and leave installation sites broom clean.

B. Prior to final acceptance, clean stairs of any paint, mud or other adherents.

END OF SECTION

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SECTION 05513 – METAL LADDERS AND ACCESSORIES

PART 1 GENERAL

1.1 THE REQUIREMENT

A. Furnish all labor, materials, equipment and incidentals required to provide complete ladders and accessories as shown on the Drawings and as specified herein.

1.2 REFERENCE SPECIFICATIONS, CODES, AND STANDARDS

A. ASTM International (ASTM)

1. ASTM B209 – Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate

2. ASTM B221 – Standard Specification for Aluminum and Aluminum-Alloy Extruded Bars, Rods, Wire, Profiles and Tubes

B. Occupational Safety and Health Standards (OSHA)

1. Code of Federal Regulations, 29 CFR, Part 1910

C. Where reference is made to one of the above standards, the revision in effect at the time of bid opening shall apply.

1.3 CONTRACTOR SUBMITTALS

A. Submit manufacturer's shop drawings, in accordance with Division 1, showing dimensions, material lists, methods of supporting, methods of anchoring, and finishes.

B. Provide templates for anchors and bolts specified for installation under other Sections.

C. Provide reaction loads for each hanger and/or bracket, as appropriate.

1.4 DELIVERY, STORAGE AND HANDLING

A. Store products in manufacturer’s unopened packaging until ready for installation.

1.5 PROJECT CONDITIONS

A. Field Measurements: Verify dimensions by field measurement before fabrication.

1.6 WARRANTY

A. Manufacturer has responsibility for an extended Corrective Period for work of this Section for a period of 5-years from the date of Substantial Completion against all the conditions indicated below. When notified in writing from the CITY, manufacturer shall promptly and without inconvenience and cost to the CITY correct said deficiencies.

1. Defects in materials and workmanship.

2. Deterioration of material and surface performance below minimum OSHA standards as certified by independent third-party testing laboratory. Ordinary wear and tear, unusual abuse or neglect excepted.

PART 2 PRODUCTS

2.1 GENERAL

A. The use of manufacturer's name and model or catalog number is for the purpose of establishing the standard of quality and general configuration desired.

B. All like materials shall be the products of one manufacturer or supplier in order to provide standardization of appearance.

2.2 FIXED WALL LADDERS

A. Fixed wall ladders, including ship's ladders, and accessories shall comply with all requirements of OSHA, 29 CFR 1910.27.

B. Ships Ladder: Incline, 75-degrees.

C. Acceptable Manufacturers:

1. Shop-fabricated from details on the Drawings

2. Precision Ladders LLC, Morristown, TN, FL Series (length as shown on the Drawings)

3. O'Keeffe's Inc. San Francisco, Model 500 (Standard)

4. Aluminex, Inc., Model LC-100 (Standard)

5. Premanufactured equal approved by the ENGINEER.

2.3 MATERIALS

A. Side Rails – Aluminum plates and bars, alloy 6061-T6 or alloy 6063-T5 for aluminum extrusions. Where side rail extensions are provided, the side rail shall be channel shape having a wall thickness not less than 0.125-in and a depth of not less than 3-in.

B. Rungs/Treads – Knurled or serrated aluminum bars, not less than 3/4-inches in diameter fabricated of alloy 6061-T6. Alternatively, serrated tubular aluminum extrusions of alloy 6063-T5/T6 not less than 1¼-inch square. Attach rungs to side rails with self-locking Type 316 Stainless Steel fasteners or weld as shown on the Drawings.

C. Wall/Floor Support Brackets - Aluminum plates, alloy 6061-T6.

2.4 LADDER SAFETY-POST EXTENSION

A. Fixed ladders occurring below grating, aluminum plank, checkered plate or hatch doors shall be provided with attached telescoping tubular safety post extension, unless otherwise noted. Unit shall be completely assembled with stainless steel fasteners and brackets for securing to the ladder rungs provided by the manufacturer. Provide corrosion resistant construction.

2.5 FALL PREVENTION SYSTEM

A. Provide complete rigid-rail and locking sleeve fall prevention system at locations noted on the Drawings. System shall be complete with all mounting hardware and accessories.

B. The fall prevention system shall be the RTC-2000 Climb Rite, as manufactured by Sellstrom; Saf-T-Climb, as manufactured by North Products, Inc., or approved equal.

C. All necessary components shall be provided, including two safety belts for each fall prevention installation to provide a complete and fully operational fall prevention system. Safety belts shall fit a waist range from 23 inches to 54 inches.

D. A rail extension shall be provided for each installation. At all locations where fall prevention systems are installed, a safety chain with a snap hook shall be permanently attached to the top of the ladder. The chain shall be long enough to allow a person to connect the belt to the chain while standing on the landing adjacent to the ladder. The chain and snap hook shall have a minimum allowable capacity of 500 pounds.

E. Safety rails and associated accessories shall match the ladder material. Except that fiberglass ladders shall have stainless steel safety rails and accessories.

F. Where ladders begin below the access platform of a structure (e.g.: meter vaults, hatchways, etc.) provide a permanently installed mandril at each ladder to allow use of the removable extension previously specified.

G. Unless otherwise designated by the ENGINEER or indicated on the Drawings, fall prevention systems shall be provided on all ladders. At minimum fall prevention system shall be provide on all ladders used to ascend heights exceeding 20 ft.

2.6 GENERAL FABRICATION

A. Details shall be as shown on the Drawings and as specified.

B. Components shall be free of splinters, sharp edges, burrs or hazardous projections.

C. For ladder rungs or capped top ends of side rails. Grind welds on exterior face of side rails or stringers smooth. Accurately fabricate joints for neat, tight fit.

D. Ships ladder: Not less than 1¼ inches, 4⅛ inch deep and 2-feet wide, tread spacing shall be 1-foot on center. Handrails shall be aluminum pipe, not less than 1½” in diameter with hemispheric end caps. Ships ladders shall be provided with seismic bottom support, minimum two isolation bearings per stringer.

E. Attachments not made by welding shall be made with self-locking Type 316 stainless steel fasteners.

F. Mill finish unless otherwise noted. Ship with a shop coat of methacrylate lacquer.

PART 3 EXECUTION

3.1 INSTALLATION

A. Install ladders and accessories in compliance with manufacturer's shop drawings and detailed instructions.

B. Install fabrications, plumb, square and level and securely anchored to supports. Smooth and adjust miters and field cuts to assure tight joints.

C. Where aluminum contacts a dissimilar metal, apply to the dissimilar a heavy brush coat of zinc-chromate primer followed by two coats of aluminum metal and masonry paint.

D. Where aluminum contacts concrete, apply a heavy coat of acceptable alkali resistant epoxy paint to the concrete.

3.2 PROTECTION

A. Protect aluminum fabrications from damage due to work of adjacent trades.

3.3 CLEANING

A. As work progresses, remove debris and leave installation sites broom clean.

B. Prior to final acceptance, clean ladders of any paint, mud or other adherents.

END OF SECTION

SECTION 05520 – ALUMINUM HANDRAILS AND GUARDRAILS

PART 1 GENERAL

1.1 THE REQUIREMENT

A. Furnish all labor, materials, equipment, incidentals, and services necessary to install aluminum handrail assemblies and guardrail systems as shown on the Drawings and as specified herein.

B. System consists of aluminum posts, guardrails, handrails, toe boards, sleeves, brackets and related work employing a stock manufactured, aluminum component railing system, and necessary custom manufactured items. Posts shall be set into holes and grouted.

1.2 REFERENCE SPECIFICATIONS, CODES, AND STANDARDS

A. ASTM International (ASTM)

1. ASTM-B210 – Standard Specification for Aluminum and Aluminum-Alloy Drawn Seamless Tube.

2. ASTM-B221 – Standard Specification for Aluminum and Aluminum-Alloy Extruded Bars, Rods, Wires, Profiles, and Tubes.

3. ASTM-B429 – Standard Specification for Aluminum-Alloy Extruded Structural Pipe and Tube.

B. International Code Council Evaluation Service (ICC-ES)

1. AC273 – Acceptance Criteria for Handrails and Guards

C. Society for Protective Coatings (SSPC)

1. SSPC-Paint 12 – Cold Applied Asphalt Mastic (Extra Thick Film).

D. National Association of Architectural Metal Manufacturers (NAAMM)

1. Metal Finishes Manual.

E. Aluminum Association (AA)

1. AA-M12C22A41 - M12 – Mechanical Finish, Non-Specular; C22 – Finish, Medium Matte; A41 – Clear Anodic Coating, Class I

F. American Architectural Manufacturers Association (AAMA)

1. AAMA 607.1

G. Where reference is made to one of the above standards, the revision in effect at the time of bid opening shall apply.

1.3 CONTRACTOR SUBMITTALS

A. Submit in accordance with Division 1, shop drawings and product data showing:

B. Shop Drawing Procedures, product data for manufacturer's product lines of handrail assemblies and guardrail systems assembled from standard components.

1. Shop Drawing Procedures, shop drawings showing fabrication and installation of handrail assemblies and guardrail systems including plans, elevations, sections, details of components, gates, and attachments to other units of Work.

2. For installed handrail assemblies and guardrail systems indicated to comply with certain design loadings, include structural analysis data, sealed and signed by the qualified Professional Civil or Structural Engineer who was responsible for their preparation.

3. Samples – Samples for verification of each type of exposed finish required, prepared on components indicated below of same thickness and metal indicated for final unit of Work. Where finishes involve normal color and texture variations, include sample sets showing the full range of variations expected.

4. Samples – 6-inch-long sections of each distinctly different linear handrail assembly and guardrail system member, including handrails, top rails, posts, and balusters.

5. Shop Drawing Procedures, qualification data for firms and persons specified in the "Quality Assurance" Article to demonstrate their capabilities and experience. Include lists of completed projects with project names and addresses, names and addresses of architects and owners, and other information specified.

C. Testing – Testing Laboratory Services, product test reports from a qualified independent testing agency, engaged by and at the expense of the Contractor, evidencing compliance of handrail assemblies and guardrail systems with requirements based on comprehensive testing of current products.

D. Certification – Testing Laboratory Services, test reports from independent testing agency, engaged by and at the expense of the Contractor, evidencing compliance of handrail assemblies and guardrail systems with ICC-ES AC273.

1.4 QUALITY ASSURANCE

A. Single-Source Responsibility – Obtain handrail assemblies and guardrail systems of each type and material from a single manufacturer.

B. All welding shall be performed by AWS qualified welders and shall conform to AWS aluminum welding code, AWS D1.2.

C. All welding procedures and welder qualification shall be available at the place of manufacture for ENGINEER's review.

D. Manufacturer's Engineer Qualifications – A Professional Civil or Structural Engineer licensed in the State of California and experienced in providing engineering services of the kind indicated that have resulted in the installation of guardrails and handrails similar to this Project in material, design, and extent and that have a record of successful in-service performance.

E. Comply with the following regulatory requirements:

1. Stair handrail and guardrail design requirements of applicable CAL-OSHA regulations.

1.5 PERFORMANCE REQUIREMENTS

A. General – In engineering handrail assemblies and guardrail systems to withstand structural loads indicated, determine allowable design working stresses of guardrail materials based on Aluminum Association (AA) "Specifications for Aluminum Structures".

B. Structural Performance of Handrail Assemblies and Guardrail Systems – Engineer, fabricate, and install guardrails and handrails in accordance with the California Building Code and tested in accordance with the requirements of ICC-ES AC273, and the following minimum requirements:

1. All handrail assemblies and guardrail systems shall be designed to resist a single concentrated load of 200 lbs applied in any direction at any point along the top and to transfer this load through the supports to the structure. This load need not be assumed to act concurrently with the 50 lb/ft specified below.

2. All handrail assemblies and guardrail systems shall be designed to resist a load of 50 lb/ft (pound force per linear foot) applied in any direction at any point along the top and to transfer this load through the supports to the structure. This load need not be assumed to act concurrently with the 200 lb load specified above.

3. All handrail assemblies and guardrail systems shall be designed for a maximum horizontal deflection at the prescribed loads, measured at the line of the vertical support, of rail height divided by 60, with rail height being the distance between the surface of the post anchorage and the top of the top rail.

4. Reductions in the aforementioned prescribed loads for building classification and/or occupancy permitted by governing Codes and/or Standards are not permissible.

C. Thermal Movements – Allow for thermal movement resulting from the following maximum change (range) in ambient temperature in engineering, fabricating, and installing handrail assemblies and guardrail systems to prevent buckling, opening of joints, overstressing of components and connections, and other detrimental effects. Base engineering calculation on actual surface temperatures of materials due to both solar heat gain and nighttime sky heat loss.

D. Temperature Change (Range) – Allowance for thermal movement shall be based on temperature change of plus or minus 90 degrees-F from the average ambient temperature at the project site, or from the temperature at time of installation, whichever is more stringent.

E. Control of Corrosion – Prevent galvanic action and other forms of corrosion by insulating metals and other materials from direct contact with incompatible materials.

1.6 DELIVERY, STORAGE AND HANDLING

A. Store handrail assemblies and guardrail systems inside a well-ventilated area, away from uncured concrete and protected from weather, moisture, soiling, abrasion, extreme temperatures, and humidity.

1.7 PROJECT CONDITIONS

A. Field Measurements – Where handrail assemblies and guardrail systems are indicated to fit to other construction, CONTRACTOR shall check actual dimensions of other construction by accurate field measurements before fabrication. CONTRACTOR shall provide field measurements to manufacturer/supplier such that they may be shown on final shop drawings. Coordinate fabrication schedule with construction progress to avoid delaying the Work.

B. Coordinate the design with the following work components:

1. Ladders and other items specified in Section 05513.

2. Gates, access points and openings where shown.

3. Equipment, conduit, valves and piping.

PART 2 PRODUCTS

2.1 GENERAL REQUIREMENTS

A. The use of manufacturer's name and model or catalog number is for the purpose of establishing the standard of quality and general configuration desired.

B. All like materials shall be the products of one manufacturer or supplier in order to provide standardization of appearance.

2.2 MANUFACTURERS

A. Available Manufacturers – Subject to compliance with requirements, manufacturers offering products that may be incorporated in the Work include, but are not limited to, the following:

1. ATR Technologies, Inc., Pomona, California

2. CraneVeyor Corp., South El Monte, California

3. Tubular Specialties Manufacturing Inc., Los Angeles, California

4. Approved equal

2.3 METALS

A. General – Provide metal free from surface blemishes where exposed to view in the finished unit. Exposed-to-view surfaces exhibiting pitting, seam marks, roller marks, stains, discolorations, or other imperfections on finished units are not acceptable.

B. Aluminum – Alloy and temper recommended by aluminum producer and finisher for type of use and finish indicated, and with not less than the strength and durability properties of the alloy and temper designated below for each aluminum form required.

1. Extruded Bar and Tube: ASTM B221, alloy 6063-T5/T52.

2. Extruded Structural Pipe and Tube: ASTM B429, 6063-T6.

3. Drawn Seamless Tube: ASTM B210, 6063-T832.

4. Plate and Sheet: ASTM B209, 6061-T6.

5. Die and Hand Forgings: ASTM B247, 6061-T6.

6. Castings: ASTM B26, A356-T6.

2.4 FASTENERS

A. Fasteners for Anchoring Handrail Assemblies and Guardrail Systems to Other Construction – Select fasteners of the type, grade, and class required to produce connections that are suitable for anchoring handrail assemblies and guardrail systems to other types of construction indicated and capable of withstanding design loadings.

1. For aluminum handrail assemblies and guardrail systems, provide fasteners fabricated from Type 304 or Type 316 Stainless Steel.

B. Fasteners for Interconnecting Handrail Assemblies and Guardrail Systems Components – Use fasteners of same basic metal as the fastened metal, unless otherwise indicated. Do not use metals that are corrosive or incompatible with materials joined.

1. Provide concealed fasteners for interconnecting handrail assemblies and guardrail systems components and for attaching them to other work, except where exposed fasteners are unavoidable or are the standard fastening method for handrail assemblies and guardrail systems indicated.

2. Provide Phillips flathead machine screws for exposed fasteners, unless otherwise indicated.

C. Cast-in-Place and Post installed Anchors – Anchors of type indicated below, fabricated from corrosion-resistant materials. Except where more stringent requirements are indicated by referenced Codes and/or Standards, anchors shall be designed for the maximum tension and shear loads obtained from design load combinations increased by an over-strength factor of 2.5.

1. Cast-In-Place Anchors – Comply with requirements Section 05500.

2. Expansion Anchors – Comply with requirements of Section 05500.

3. Adhesive Anchors – Comply with requirements of Section 05500.

2.5 PAINT

A. Bituminous Paint – Cold-applied asphalt mastic complying with SSPC-Paint 12, except containing no asbestos fibers.

2.6 GROUT

A. Comply with requirements of Section 03600.

2.7 FABRICATION

A. General – Fabricate handrail assemblies and guardrail systems to comply with requirements indicated for design, dimensions, details, finish, and member sizes, including wall thickness of hollow members, post spacing, and anchorage, but not less than that required to support structural loads.

B. Assemble handrail assemblies and guardrail systems in shop to the greatest extent possible to minimize field splicing and assembly. Disassemble units only as necessary for shipping and handling limitations. Clearly mark units for reassembly and coordinated installation. Use connections that maintain structural value of joined pieces.

C. Form simple and compound curves by bending members in jigs to produce uniform curvature for each repetitive configuration required; maintain profile of member throughout entire bend without buckling, twisting, cracking, or otherwise deforming exposed surfaces of handrail assemblies and guardrail systems components.

D. Non-welded Connections – Fabricate handrail assemblies and guardrail systems by connecting members with guardrail manufacturer's standard concealed mechanical fasteners and fittings, unless otherwise indicated. Fabricate members and fittings to produce flush, smooth, rigid, hairline joints.

E. Brackets, Flanges, Fittings, and Anchors – Unless noted or shown otherwise, provide manufacturer's standard wall brackets, flanges, miscellaneous fittings, and anchors to connect handrail assemblies and guardrail systems members to other construction.

F. Provide inserts and other anchorage devices to connect handrail assemblies and guardrail systems to concrete work. Fabricate anchorage devices capable of withstanding loads imposed by handrail assembly and guardrail system. Coordinate anchorage devices with supporting structure.

G. For removable railing posts, fabricate slip-fit sockets from aluminum pipe whose inside diameter is sized for a close fit with posts and to limit deflection of post without lateral load, measured at top, to not more than 1/12 of post height. Provide socket covers designed and fabricated to resist accidental dislodgement.

H. Shear and punch metals cleanly and accurately. Remove burrs from exposed cut edges.

I. Ease exposed edges to a radius of approximately 1/32 inch, unless otherwise indicated. Form bent-metal corners to the smallest radius possible without causing grain separation or otherwise impairing work.

J. Cut, reinforce, drill, and tap components, as indicated, to receive finish hardware, screws, and similar items.

K. Provide weep holes or other means to drain entrapped water in hollow sections of guardrail members that are exposed to exterior or to moisture from condensation or other sources.

L. Fabricate joints that will be exposed to weather in a watertight manner.

M. Close exposed ends of handrail assemblies and guardrail systems members with prefabricated end fittings.

N. Provide wall returns at ends of wall-mounted handrail assemblies, unless otherwise indicated. Close ends of returns unless clearance between end of the handrail and wall is ¼-inch or less.

O. Toe Boards – Provide 4-inch tall toe boards at all open guardrail around platforms, landings, and walkways and in accordance with CAL-OSHA and where shown on the drawings. Fabricate to dimensions and details indicated. Attach toe boards to posts, ¼-inch maximum above the walking surface or stringer, using two self-tapping, stainless steel machine screws minimum at each connection. Use special toe board connectors at corners and special splice plates at end joints. Fasteners shall face away from walking surfaces whenever possible. Fasteners facing walking surfaces shall be countersunk or round-headed. Sharp edges at corners shall be eased.

P. Fillers – Provide steel sheet or plate fillers of thickness and size indicated or required to support structural loads of handrails where needed to transfer wall bracket loads through wall finishes to structural supports. Size fillers to suit wall finish thickness. Size fillers to produce adequate bearing to prevent bracket rotation and overstressing of substrate.

Q. Gates – Provide swing-type gates where indicated. Unless otherwise shown, fabricate gates with components to match adjacent guardrails. Furnish gates with aluminum or stainless steel hinges and keeper/latch mechanism.

2.8 FINISH

A. Comply with NAAMM "Metal Finishes Manual" for recommendations relative to applying and designating finishes.

B. Finish designations prefixed by AA conform to the system established by the Aluminum Association for designating aluminum finishes.

C. Class I, Clear Anodic Finish: AA-M12C22A41 (Mechanical Finish: non-specular as fabricated; Chemical Finish: etched, medium matte; Anodic Coating: Architectural Class I, clear coating 0.7 mil or thicker) complying with AAMA 607.1.

PART 3 EXECUTION

3.1 PREPARATION

A. Coordinate setting drawings, diagrams, templates, instructions, and directions for installing anchorages, such as sleeves, concrete inserts, anchor bolts, and miscellaneous items having integral anchors, which are to be embedded in concrete construction. Coordinate delivery of such items to Project site.

3.2 INSTALLATION - GENERAL

A. Fit exposed connections accurately together to form tight, hairline joints.

B. Cutting, Fitting, and Placement – Perform cutting, drilling, and fitting required for installing handrail assemblies and guardrail systems. Set handrail assemblies and guardrail systems accurately in location, alignment, and elevation, measured from established lines and levels and free from rack.

1. Do not weld, cut, or abrade surfaces of handrail assembly and guardrail system components that have been coated or finished after fabrication and are intended for field connection by mechanical or other means without further cutting or fitting.

2. Set posts plumb.

3. Align rails so that variations from level for horizontal members and from parallel with rake of steps and ramps for sloping members do not exceed ¼-inch in 12 feet.

C. Corrosion Protection – Coat concealed surfaces of aluminum that will be in contact with grout, concrete, masonry, wood, or dissimilar metals, with one coat of TT-P-645B zinc-molybdate primer or a heavy coat of approved alkali resistant bituminous paint.

D. Electrolysis Protection – Insert ¼ inch-thick neoprene isolator pads, 85 plus/minus 5 Shore-A-Durometer, sized for full width and length between aluminum grating, aluminum tread plate, aluminum stairs treads or aluminum brackets and structural steel support brackets and/or supports.

E. Adjust handrail assemblies and guardrail systems prior to anchoring to ensure matching alignment at abutting joints. Space posts at interval indicated but not more than that required by structural loads.

F. Fastening to In-Place Construction – Use anchorage devices and fasteners where necessary for securing handrail assemblies and guardrail systems and for properly transferring loads to in-place construction.

3.3 GUARDRAIL CONNECTIONS

A. Non-welded Connections – Use mechanical joints for permanently connecting guardrail system components. Seal recessed holes of exposed locking screws using plastic filler, cement colored to match finish of guardrails and handrails.

B. Expansion Joints – Install expansion joints at locations indicated but not further apart than required to accommodate thermal movement. Provide slip-joint internal sleeve extending 2-inches beyond joint on either side; fasten internal sleeve securely to one side; locate joint within 6-inches of post.

3.4 ANCHORING POSTS

A. Anchor posts in concrete by forming or core-drilling holes not less than 6-inches deep and ¾-inch greater than outside diameter of post. Clean holes of all loose material, insert posts, and fill annular space between post and concrete with nonshrink, nonmetallic grout, mixed and placed to comply with anchoring material manufacturer's directions.

B. Leave anchorage joint exposed, wipe off surplus anchoring material, and leave 1/8-inch buildup, sloped away from post.

C. Anchor posts to metal surfaces with oval flanges, angle type or floor type as required by conditions, connected to posts and to metal supporting members as follows:

1. For aluminum handrail assemblies and guardrail systems, attach posts as indicated using fittings designed and engineered for this purpose.

D. Install removable guardrail system sections where indicated in slip-fit metal sockets cast into concrete. Accurately locate sockets to match post spacing.

3.5 ANCHORING RAIL ENDS

A. Anchor rail ends into concrete with round flanges connected to rail ends and anchored into wall construction with post installed anchors and bolts.

B. Anchor rail ends to metal surfaces with oval or round flanges.

1. Connect flanges to rail ends using non-welded connections.

3.6 ATTACHING HANDRAIL ASSEMBLIES TO WALLS

A. Attach handrail assemblies to wall with wall brackets and end fittings. Provide bracket with 1½ -inches clearance from inside face of handrail assembly and finished wall surface.

B. Locate brackets as indicated or, if not indicated, at spacing required to support structural loads.

C. Secure wall brackets and wall return fittings to building construction as follows.

1. Use type of bracket with predrilled hole for exposed bolt anchorage.

2. For concrete anchorage, use drilled-in expansion shield and either concealed hanger bolt or exposed lag bolt, as applicable.

3. For steel-framed gypsum board assemblies, fasten brackets directly to steel framing or concealed reinforcements using self-tapping screws of size and type required to support structural loads.

3.7 ADJUSTING AND CLEANING

A. Clean soiled surfaces by washing thoroughly with clean water and soap, followed by rinsing with clean water.

3.8 PROTECTION

A. Protect finishes of handrail assemblies and guardrail systems from damage during construction period with temporary protective coverings approved by handrail assembly and guardrail system manufacturer. Remove protective coverings at the time of Final Completion.

B. Restore finishes damaged during installation and construction period so that no evidence remains of correction work. Return items that cannot be refinished in the field to the shop; make required alterations and refinish entire unit, or provide new units at no additional cost to the CITY.

END OF SECTION

SECTION 06072 - MISCELLANEOUS ROUGH CARPENTRY

PART 1 GENERAL

1.1 SUMMARY

A. Section Includes:

1. Wood blocking.

2. Plywood backing panels.

B. Related Sections include the following:

1. Section 07415 – Metal Roof and Walls

1.2 DEFINITIONS

A. Dimension Lumber: Lumber of 2 inches nominal (38 mm actual) or greater but less than 5 inches nominal (114 mm actual) in least dimension.

B. Lumber grading agencies, and the abbreviations used to reference them, include the following:

1. NHLA: National Hardwood Lumber Association.

2. NLGA: National Lumber Grades Authority.

3. WCLIB: West Coast Lumber Inspection Bureau.

4. WWPA: Western Wood Products Association.

1.3 SUBMITTALS

A. Product Data: For each type of process and factory-fabricated product. Indicate component materials and dimensions and include construction and application details.

1. Include data for wood-preservative treatment from chemical treatment manufacturer and certification by treating plant that treated materials comply with requirements. Indicate type of preservative used and net amount of preservative retained.

2. Include data for fire-retardant treatment from chemical treatment manufacturer and certification by treating plant that treated materials comply with requirements. Include physical properties of treated materials based on testing by a qualified independent testing agency.

3. For fire-retardant treatments, include physical properties of treated lumber both before and after exposure to elevated temperatures, based on testing by a qualified independent testing agency according to ASTM D 5664.

4. For products receiving a waterborne treatment, include statement that moisture content of treated materials was reduced to levels specified before shipment to Project site.

5. Include copies of warranties from chemical treatment manufacturers for each type of treatment.

6. Product Data for Low-Emitting Materials: For adhesives, documentation including printed statement of VOC content.

7. Product Data for Low-Emitting Wood Products: For plywood, documentation that products contain no added urea formaldehyde.

B. Evaluation Reports: For the following, from ICC-ES:

1. Preservative-treated wood.

2. Fire-retardant-treated wood.

3. Powder-actuated fasteners.

4. Expansion anchors.

1.4 QUALITY ASSURANCE

A. Testing Agency Qualifications: For testing agency providing classification marking for fire-retardant treated material, an inspection agency acceptable to authorities having jurisdiction that periodically performs inspections to verify that the material bearing the classification marking is representative of the material tested.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Stack lumber flat with spacers beneath and between each bundle to provide air circulation. Protect lumber from weather by covering with waterproof sheeting, securely anchored. Provide for air circulation around stacks and under coverings.

PART 2 - PRODUCTS

2.1 WOOD PRODUCTS, GENERAL

A. Lumber: DOC PS 20 and applicable rules of grading agencies indicated. If no grading agency is indicated, provide lumber that complies with the applicable rules of any rules-writing agency certified by the ALSC Board of Review. Provide lumber graded by an agency certified by the ALSC Board of Review to inspect and grade lumber under the rules indicated.

1. Factory mark each piece of lumber with grade stamp of grading agency.

2. Where nominal sizes are indicated, provide actual sizes required by DOC PS 20 for moisture content specified. Where actual sizes are indicated, they are minimum dressed sizes for dry lumber.

3. Provide dressed lumber, S4S, unless otherwise indicated.

B. Maximum Moisture Content of Lumber: 19 percent unless otherwise indicated.

2.2 WOOD-PRESERVATIVE-TREATED MATERIALS

A. Preservative Treatment by Pressure Process: AWPA U1; Use Category UC2 for interior construction not in contact with the ground, Use Category UC3b for exterior construction not in contact with the ground, and Use Category UC4a for items in contact with the ground.

1. Preservative Chemicals: Acceptable to authorities having jurisdiction and containing no arsenic or chromium.

B. Kiln-dry lumber after treatment to a maximum moisture content of 19 percent. Do not use material that is warped or does not comply with requirements for untreated material.

C. Mark lumber with treatment quality mark of an inspection agency approved by the ALSC Board of Review.

D. Application: Treat items indicated on Drawings, and the following:

1. Wood blocking in connection with roofing, flashing, vapor barriers, and waterproofing.

2. Wood sills, sleepers, blocking, furring, and similar concealed members in contact with masonry or concrete.

2.3 FIRE-RETARDANT-TREATED MATERIALS

A. General: Where fire-retardant-treated materials are indicated, use materials complying with requirements in this article, that are acceptable to authorities having jurisdiction, and with fire-test-response characteristics specified as determined by testing identical products per test method indicated by a qualified testing agency.

B. Fire-Retardant-Treated Lumber and Plywood by Pressure Process: Products with a flame spread index of 25 or less when tested according to ASTM E 84, and with no evidence of significant progressive combustion when the test is extended an additional 20 minutes, and with the flame front not extending more than 10.5 feet (3.2 m) beyond the centerline of the burners at any time during the test.

1. Use treatment that does not promote corrosion of metal fasteners.

2. Exterior Type: Treated materials shall comply with requirements specified above for fire-retardant-treated lumber and plywood by pressure process after being subjected to accelerated weathering according to ASTM D 2898. Use for exterior locations and where indicated.

3. Interior Type A: Treated materials shall have a moisture content of 28 percent or less when tested according to ASTM D 3201 at 92 percent relative humidity. Use where exterior type is not indicated.

4. Design Value Adjustment Factors: Treated lumber shall be tested according ASTM D 5664, and design value adjustment factors shall be calculated according to ASTM D 6841.

C. Kiln-dry lumber after treatment to a maximum moisture content of 19 percent. Kiln-dry plywood after treatment to a maximum moisture content of 15 percent.

D. Identify fire-retardant-treated wood with appropriate classification marking of testing and inspecting agency acceptable to authorities having jurisdiction.

E. Application: Treat items indicated on Drawings, and the following:

1. Concealed blocking.

2. Wood blocking in connection with roofing.

3. Plywood backing panels.

2.4 MISCELLANEOUS LUMBER

A. General: Provide miscellaneous lumber indicated and lumber for support or attachment of other construction, including the following:

1. Blocking.

B. For items of dimension lumber size, provide Standard, Stud, or No. 3 grade lumber and any of the following species:

1. Western woods; WCLIB or WWPA.

2. Northern species; NLGA.

C. For concealed boards, provide lumber with 19 percent maximum moisture content and any of the following species and grades:

1. Northern species, No. 3 Common grade; NLGA.

2. Western woods, Standard or No. 3 Common grade; WCLIB or WWPA.

D. For blocking not used for attachment of other construction, Utility, Stud, or No. 3 grade lumber of any species may be used provided that it is cut and selected to eliminate defects that will interfere with its attachment and purpose.

E. For blocking used for attachment of other construction, select and cut lumber to eliminate knots and other defects that will interfere with attachment of other work.

2.5 PLYWOOD BACKING PANELS

A. Equipment Backing Panels: DOC PS 1, Exterior, AC, fire-retardant treated, in thickness indicated or, if not indicated, not less than 1/2-inch (13-mm) nominal thickness.

2.6 FASTENERS

A. General: Provide fasteners of size and type indicated that comply with requirements specified in this article for material and manufacture.

1. Where carpentry is exposed to weather, in ground contact, pressure-preservative treated, or in area of high relative humidity, provide fasteners of Type 304 stainless steel.

B. Nails, Brads, and Staples: ASTM F 1667.

C. Wood Screws: ASME B18.6.1.

D. Screws for Fastening to Metal Framing: ASTM C 1002 and ASTM C 954 according to framing type, length as recommended by screw manufacturer for material being fastened.

E. Expansion Anchors: Anchor bolt and sleeve assembly of material indicated below with capability to sustain, without failure, a load equal to 6 times the load imposed when installed in unit masonry assemblies and equal to 4 times the load imposed when installed in concrete as determined by testing per ASTM E 488 conducted by a qualified independent testing and inspecting agency.

1. Material: Carbon-steel components, zinc plated to comply with ASTM B 633, Class Fe/Zn 5.

2.7 MISCELLANEOUS MATERIALS

A. Adhesives for Gluing Furring to Concrete or Masonry: Formulation complying with ASTM D 3498 that is approved for use indicated by adhesive manufacturer.

1. Adhesives shall have a VOC content of 70 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

B. Flexible Flashing: Composite, self-adhesive, flashing product consisting of a pliable, butyl rubber or rubberized-asphalt compound, bonded to a high-density polyethylene film, aluminum foil, or spunbonded polyolefin to produce an overall thickness of not less than 0.025 inch (0.6 mm).

PART 3 - EXECUTION

3.1 INSTALLATION, GENERAL

A. Set carpentry to required levels and lines, with members plumb, true to line, cut, and fitted. Fit carpentry to other construction; scribe and cope as needed for accurate fit. Locate blocking and similar supports to comply with requirements for attaching other construction.

B. Where wood-preservative-treated lumber is installed adjacent to metal decking, install continuous flexible flashing separator between wood and metal decking.

C. Install plywood backing panels by fastening to studs; coordinate locations with utilities requiring backing panels. Install fire-retardant treated plywood backing panels with classification marking of testing agency exposed to view.

D. Do not splice structural members between supports unless otherwise indicated.

E. Provide blocking as indicated and as required to support facing materials, fixtures, specialty items, and trim.

1. Provide metal clips for fastening gypsum board or lath at corners and intersections where framing or blocking does not provide a surface for fastening edges of panels. Space clips not more than 16 inches (406 mm) o.c.

F. Sort and select lumber so that natural characteristics will not interfere with installation or with fastening other materials to lumber. Do not use materials with defects that interfere with function of member or pieces that are too small to use with minimum number of joints or optimum joint arrangement.

G. Comply with AWPA M4 for applying field treatment to cut surfaces of preservative-treated lumber.

1. Use inorganic boron for items that are continuously protected from liquid water.

2. Use copper naphthenate for items not continuously protected from liquid water.

H. Securely attach carpentry work to substrate by anchoring and fastening as indicated, complying with the following:

1. Table 2304.9.1, "Fastening Schedule," in ICC's International Building Code.

I. Use steel common nails unless otherwise indicated. Select fasteners of size that will not fully penetrate members where opposite side will be exposed to view or will receive finish materials. Make tight connections between members. Install fasteners without splitting wood. Drive nails snug but do not countersink nail heads unless otherwise indicated.

3.2 WOOD BLOCKING INSTALLATION

A. Install where indicated and where required for attaching other work. Form to shapes indicated and cut as required for true line and level of attached work. Coordinate locations with other work involved.

B. Attach items to substrates to support applied loading. Recess bolts and nuts flush with surfaces unless otherwise indicated.

3.3 PROTECTION

A. Protect wood that has been treated with inorganic boron (SBX) from weather. If, despite protection, inorganic boron-treated wood becomes wet, apply EPA-registered borate treatment. Apply borate solution by spraying to comply with EPA-registered label.

B. Protect miscellaneous rough carpentry from weather. If, despite protection, miscellaneous rough carpentry becomes wet, apply EPA-registered borate treatment. Apply borate solution by spraying to comply with EPA-registered label.

END OF SECTION

SECTION 06608 - PLASTIC PANELING

PART 1 GENERAL

1.1 SUMMARY

A. Section Includes:

1. Plastic sheet paneling.

1.2 SUBMITTALS

A. Product Data: For each type of product.

B. Samples: For plastic paneling and trim accessories, in manufacturer's standard sizes.

1.3 PROJECT CONDITIONS

A. Environmental Limitations: Do not deliver or install plastic paneling until spaces are enclosed and weathertight and temporary HVAC system is operating and maintaining ambient temperature and humidity conditions at occupancy levels during the remainder of the construction period.

PART 2 PRODUCTS

2.1 MANUFACTURERS

A. Source Limitations: Obtain plastic paneling and trim accessories from single manufacturer.

2.2 PLASTIC SHEET PANELING

A. Glass-Fiber-Reinforced Plastic Paneling: Gelcoat-finished, glass-fiber-reinforced plastic panels complying with ASTM D 5319.

1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to the following:

a. Marlite; Standard FRP.
b. Crane Composites, Inc.; Sequentia.

2. Surface-Burning Characteristics: As follows when tested by a qualified testing agency according to ASTM E 84. Identify products with appropriate markings of applicable testing agency.

a. Flame-Spread Index: 200 or less.
b. Smoke-Developed Index: 450 or less.

3. Nominal Thickness: Not less than 2.3 mm (0.09 inch).

4. Surface Finish: Smooth.

5. Color: White.

2.3 ACCESSORIES

A. Trim Accessories: Manufacturer's standard one-piece vinyl extrusions designed to retain and cover edges of panels. Provide division bars, inside corners, outside corners, and caps as needed to conceal edges.

1. Color: White.

B. Adhesive: As recommended by plastic paneling manufacturer.

1. Adhesives shall have a VOC content of 50 g/L or less.

C. Sealant: Mildew-resistant, single-component, neutral-curing or acid-curing silicone sealant recommended by plastic paneling manufacturer and complying with requirements in Section 07920 "Joint Sealants."

1. Sealant shall have a VOC content of 250 g/L or less.

PART 3 EXECUTION

3.1 EXAMINATION

A. Examine substrates and conditions, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

A. Remove loose or soluble paint, and other materials that might interfere with adhesive bond.

B. Prepare substrate by sanding high spots and filling low spots as needed to provide flat, even surface for panel installation.

C. Clean substrates of substances that could impair adhesive bond, including oil, grease, dirt, and dust.

D. Condition panels by unpacking and placing in installation space before installation according to manufacturer's written recommendations.

E. Lay out paneling before installing. Locate panel joints so that trimmed panels at corners are not less than 300 mm (12 inches) wide.

1. Mark plumb lines on substrate at trim accessory locations for accurate installation.

2. Locate trim accessories to allow clearance at panel edges according to manufacturer's written instructions.

3.3 INSTALLATION

A. Install plastic paneling according to manufacturer's written instructions.

B. Install panels in a full spread of adhesive.

C. Install trim accessories with adhesive or staples. Do not fasten through panels.

D. Fill grooves in trim accessories with sealant before installing panels, and bed inside corner trim in a bead of sealant.

E. Remove excess sealant and smears as paneling is installed. Clean with solvent recommended by sealant manufacturer and then wipe with clean dry cloths until no residue remains.

END OF SECTION

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SECTION 07190 - WATER REPELLENTS

PART 1 GENERAL

1.1 THE REQUIREMENTS

A. Section Includes:

1. Section Includes: Water repellent for all exterior exposed concrete, complete.

1.2 DEFINITIONS

A. Water Repellent: Resistance to penetration of water from rainfall.

1.3 SYSTEM DESCRIPTION

A. Performance Requirements: Surfaces with water repellent shall be uniform in color with unaltered texture.

1.4 SUBMITTALS

A. Product Data.

B. Samples: Water repellent applied on 8 inch by 8 inch substrates to receive water repellent, marked with application date and application rate.

C. Manufacturer's Application Instructions.

1.5 QUALITY ASSURANCE

A. Manufacturer Qualifications: Manufacturer of water repellents for minimum 5 years with satisfactory performance record.

B. Applicator Qualifications: Trained, approved, and accepted by water repellent manufacturer, and having minimum 2 years of experience spraying exotic coatings.

C. Regulatory Requirements: Comply with volatile organic compound regulations.

D. Mock-Ups:

1. Apply water repellent on 8 by 8 foot section of wall. Use same equipment and procedures that will be used in applying material on walls.

2. Test for water penetration in accordance with field quality control.

3. When accepted by the ENGINEER, mock-up walls will be standard for walls.

1.6 PROJECT CONDITIONS

A. Environmental Requirements: Apply water repellent under temperature and relative humidity conditions before, during, and after application in accordance with manufacturer's instructions. Allow surfaces to dry for minimum 5 days after rains.

B. Make proper material allowance based upon substrate material and surface configuration when determining quantities of material.

1.7 WARRANTY

A. Warrant to furnish and apply water repellent on walls that experience water penetration because of failure of water repellent for minimum 5 years.

PART 2 PRODUCTS

2.1 MANUFACTURERS

A. Water Repellent Sealer:

1. Manufacturers: One of the following or equal:

a. Rainguard Products, Inglewood, CA.
b. ProSoCo, Inc., Kansas City, KS.

2.2 MATERIALS

A. Water Repellent Sealer for Concrete and Concrete Masonry: Silane/Siloxane; Volatile Organic Compound compliant; free of silicone oils, paraffin wax, or urethanes; one of the following or equal:

1. Rainguard, BLOK-LOK.

2.3 EQUIPMENT

A. Spray Equipment: High-volume, low-pressure, airless, with maximum 60 pounds per square inch pressure.

1. Pump: Non-atomizing, able to flow material on walls at minimum 1 to 1-1/2 gallons per minute.

2. Orifice Size for Concrete, Slump Block, Exposed Concrete Aggregate, and Cement Plaster: 0.060 to 0.110 inches.

PART 3 EXECUTION

3.1 EXAMINATION

A. Inspect installed construction. Verify that construction is ready for repellent application. Require manufacturer's representative to verify that water repellent may be installed.

3.2 PREPARATION

A. Allow concrete or masonry walls to cure at least 30 days before applying water repellent.

B. Clean wall surfaces of soil, mud, efflorescence, or other detrimental materials.

C. Tuck-point or caulk cracks, other than hairline cracks.

D. Route out defective mortar joints, point with mortar and tool.

E. Moisture Content: Apply water repellent sealer when moisture content of substrate is 15 percent or less.

F. Test substrate surfaces for moisture content with "Electronic Moisture Register - Model B." Take 1 reading for each 200 square feet of wall area and tabulate results.

3.3 APPLICATION ON CONCRETE AND CONCRETE MASONRY

A. Apply water repellent in accordance with manufacturer's printed instructions.

B. Apply flood coat using low-pressure spray equipment.

C. Start at top of wall and work down using overlapping horizontal passes.

D. Hold spray head 8 to 10 inches from surface so saturation coat runs freely down wall 6 to 10 inches below point of application on most substrates.

E. Spray by traveling horizontally to ensure uniform coverage.

F. Overlap each following pass by centering spray head on bottom line of the previous pass.

G. Trigger gun off at end of each pass to avoid applying excessive amount of material. Do not overapply.

H. Avoid application in hot windy weather as premature drying can cause whitish residue on walls.

3.4 FIELD QUALITY CONTROL

A. Test water repellent with running water 20 days after application.

B. Notify the ENGINEER and manufacturer at least 72 hours in advance of test. Conduct test in the ENGINEER's and manufacturer's presence.

C. Use 3/4-inch garden hose with garden type spray nozzle, and outrigger or similar acceptable equipment. Place 8 to 10 feet from wall where designated by the ENGINEER. Aim nozzle so water strikes wall at 45-degree downward angle.

D. Run water onto wall at full available force for minimum 4 hours. Make provisions to collect run off water into containers for possible reuse.

E. Inspect interior surface of wall for evidence of moisture penetration.

F. Where evidence of moisture penetration is discovered, apply additional coat of water repellent on entire wall from corner to corner.

G. Test other locations where directed by the ENGINEER.

3.5 CLEANING

A. Concrete: Clean drips, runs, and overspray residue while still wet, using detergent and water. Clean application and spray equipment with detergent and water immediately following use.

B. Clean application and spray equipment according to the manufacturer's recommendations.

C. Remove excess materials, equipment, and debris incidental to water repellent application upon completion.

3.6 PROTECTION

A. During application, protect water repellent treated and adjacent surfaces from damage.

B. Protect glass, aluminum, and other surfaces from overspray.

C. Protect concrete sidewalks from runoff. Soak with water immediately prior to application on adjacent walls.

D. Repair damaged areas promptly.

END OF SECTION

SECTION 07210 - THERMAL INSULATION

PART 1 GENERAL

1.1 SUMMARY

A. Section Includes:

1. Glass-fiber blanket insulation.

2. Acoustical insulation at interior acoustical walls and ceilings.

   a. Walls: Blower/Maintenance Building Blower Room, and Biosolids Dryer Building Electrical and Thermal Oil Rooms.
   b. Ceiling: Blower/Maintenance Building Blower Room.

3. Flexible foam insulation for filling perimeter gaps at windows, doors, and penetrations.

4. Vapor Retarder.

B. Related Sections:

1. Section 09110 "Non-Structural Metal Framing" for insulation attached by Z-shaped furring.

1.2 SUBMITTALS

A. Product Data: For each type of product indicated.

B. Product Test Reports: Based on evaluation of comprehensive tests performed by a qualified testing agency, for each product.

1.3 QUALITY ASSURANCE

A. Surface-Burning Characteristics: As determined by testing identical products according to ASTM E 84 by a qualified testing agency. Identify products with appropriate markings of applicable testing agency.

1.4 DELIVERY, STORAGE, AND HANDLING

A. Protect insulation materials from physical damage and from deterioration due to moisture, soiling, and other sources. Store inside and in a dry location. Comply with manufacturer's written instructions for handling, storing, and protecting during installation.

B. Protect foam-plastic board insulation as follows:

1. Do not expose to sunlight except to necessary extent for period of installation and concealment.

2. Protect against ignition at all times. Do not deliver foam-plastic board materials to Project site until just before installation time.

3. Quickly complete installation and concealment of foam-plastic board insulation in each area of construction.

PART 2 PRODUCTS

2.1 GLASS-FIBER BLANKET INSULATION

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. CertainTeed Corporation.

2. Johns Manville.

3. Knauf Insulation.

B. Concealed Batt Insulation: Unfaced, Glass-Fiber Blanket Insulation: ASTM C 665, Type I; with maximum flame-spread and smoke-developed indexes of 25 and 50, respectively, per ASTM E 84; passing ASTM E 136 for combustion characteristics.

C. Acoustical Batt Insulation: Glass-Fiber Blanket Insulation: ASTM C 665, Type II or III, Class C; with maximum flame-spread and smoke-developed indexes of 25 and 50, respectively, per ASTM E 84; passing ASTM E 136 for combustion characteristics.

D. Performance: Provide the following insulating values, unless otherwise indicated.

1. Roofs: R 30.

2. Exterior Walls: R 25

3. Interior Walls : R 19, 6” nominal thickness.

E. Sustainability Requirements: Provide glass-fiber blanket insulation complying with one of the following:

1. Free of Formaldehyde: Insulation manufactured with 100 percent acrylic binders and no formaldehyde.

2. Low Emitting: Insulation tested according to ASTM D 5116 and shown to emit less than 0.05-ppm formaldehyde.

2.2 FLEXIBLE FOAM INSULATION

A. Foamed-in-Place Insulation at Penetrations, Cracks, and Gaps Around Windows and Exterior Door Frames: Minimal-expanding, single-component, flexible, insulating latex-based foam sealant, in aerosol cans; DAP "DAPtex Latex Multi-Purpose Insulating Foam Sealant", or equal, containing no CFC or HCFC blowing agents.

2.3 VAPOR RETARDER

A. Sheet Retarder: Polyamide film vapor retarder for use with unfaced, vapor permeable glass fiber insulation in wall and ceiling cavities.

1. Water Vapor Permeance:

    a. ASTM E 86, dry cup method: 1.0 perms (57ng/Pa*s*m2).
    b. ASTM E 86, wet cup method: 10.0 perms (1144ng/Pa*s*m2).

2. Fire Hazard Classification: ASTM E 84:

    a. Maximum Flame Spread Index; 20.
    b. Maximum Smoke Developed Index; 55.

3. Color: White.

4. Accessories:

    a. Adhesive: Application temperature 10 degrees F to 110 degrees F.
    b. Double sided tape: Width 0.75 “. Rubber based and free film.
    c. Patch tape: Adhesive added to one side. Application temperature 10 degrees F to 110 degrees F. 3” width.
    d. Metal Banding straps: 1’ wide coated steel. Structural Grade 50 per ASTM C653. Exposed color to match vapor barrier.

PART 3 EXECUTION

3.1 PREPARATION

A. Clean substrates of substances that are harmful to insulation, including removing projections that interfere with insulation attachment.

3.2 INSTALLATION, GENERAL

A. Comply with insulation manufacturer's written instructions applicable to products and applications indicated.

B. Install insulation that is undamaged, dry, and unsoiled and that has not been left exposed to ice, rain, or snow at any time.

C. Extend insulation to envelop entire area to be insulated. Cut and fit tightly around obstructions and fill voids with insulation. Remove projections that interfere with placement.

D. Provide sizes to fit applications indicated and selected from manufacturer's standard thicknesses, widths, and lengths. Apply single layer of insulation units to produce thickness indicated unless multiple layers are otherwise shown or required to make up total thickness.

3.3 INSTALLATION OF INSULATION FOR FRAMED CONSTRUCTION

A. Unfaced Glass-Fiber or Mineral-Wool Blanket Insulation: Install in cavities formed by framing members according to the following requirements:

    1. Use insulation widths and lengths that fill the cavities formed by framing members. If more than one length is required to fill the cavities, provide lengths that will produce a snug fit between ends.

2. Place insulation in cavities formed by framing members to produce a friction fit between edges of insulation and adjoining framing members.

3. For metal-framed wall cavities where cavity heights exceed 96 inches (2438 mm), support unfaced blankets mechanically and support faced blankets by taping flanges of insulation to flanges of metal studs.

B. Miscellaneous Voids: Install insulation in miscellaneous voids and cavity spaces where required to prevent gaps in insulation using the following materials:

1. Glass-Fiber Insulation: Compact to approximately 40 percent of normal maximum volume equaling a density of approximately 2.5 lb/cu. ft. (40 kg/cu. m).

3.4 INSTALLATION OF INSULATION FOR SOUND ATTENUATION

A. Where glass-fiber blankets are indicated for sound attenuation in walls and partitions, install blanket insulation to fill stud cavities.

3.5 INSTALLATION OF VAPOR RETARDER

A. Install vapor retarder in accordance with manufacturer's installation instructions and approved Shop Drawings.

B. Purlin and girt attachment surfaces should be clean and dry prior to attaching two-faced tape or sealing adhesive.

3.6 PROTECTION

A. Protect installed insulation from damage due to harmful weather exposures, physical abuse, and other causes. Provide temporary coverings or enclosures where insulation is subject to abuse and cannot be concealed and protected by permanent construction immediately after installation.

END OF SECTION

SECTION 07415 - METAL ROOF AND WALL PANELS

PART 1 GENERAL

1.1 SUMMARY

A. Section Includes:

1. Preformed standing seam metal roofing system.

2. Preformed low-slope metal roofing system.

3. Preformed metal siding systems.

4. Girts, miscellaneous supports, flashings, exposed sheet metal, trim, caps, closures, fasteners, and sealants associated with the work of this Section.

B. Related Sections:

1. Section 01614 - Wind Design Criteria.

2. Section 13340 - Metal Building Systems.

1.2 PERFORMANCE REQUIREMENTS

A. Roof Design Load: Install the preformed metal roofing work capable of supporting roofing dead and live loads and a design load of 20 psf with deflection no greater than L/240.

B. Roof Wind Uplift: Install metal roofing for UL580 Class 90 wind uplift.

C. Wall Wind Design: Install metal wall panels capable of withstanding a basic wind speed of 85 mph with 3 second gusts, exposure category 3, occupancy category II, and to meet FM Global Wind Design criteria for materials and components. Refer to Section 01614 and Section13340 for additional information.

D. Air and Water-Infiltration Requirements: Furnish and install the metal roof panels so that no air or water infiltrates through the panels, as tested in accordance with ASTM E1680 and E1646 respectively.

E. Thermal Movements: Install the metal panels capable of withstanding thermal expansion and contraction movements for ambient temperature from 20-120 degrees F without failure of any kind.

1.3 SUBMITTALS

A. Shop Drawings: Submit shop drawings indicating dimensions, elevations, panel layout, construction details, method of anchorage, trim, accessories, and method and sequence of installation.

B. Product Data: Submit manufacturer's product data sheets and installation instructions for all metal materials and profiles.

C. Samples: Submit color samples not less than 8 x 10 inches in size on actual materials illustrating colors and finishes selected.

1.4 QUALITY ASSURANCE

A. Installer Qualifications: Firm experienced in installing work of this section, approved by the manufacturer, and experienced in coordinating this work with the work of other sections.

1.05 DELIVERY, STORAGE, AND HANDLING

A. Examine materials and surfaces for damage before off-loading. Do not accept damaged materials.

B. Protect the finished metal surfaces from damage and abrasion during delivery, storage, and handling. Any surface having noticeable and objectionable damage of abrasion, as deemed by the Engineer will be rejected.

1.6 WARRANTY

A. Manufacturer Warranty: Provide a manufacturer's 20 year NDL warranty for entire roofing system, warranting that roofing system will not leak water, deteriorate, or otherwise fail to perform as required.

B. Contractor and Subcontractor: Jointly guarantee for a period of five (5) years from the date of final acceptance that the metal roof system shall be free of defects in material and installation and that it will not leak water, deteriorate, or otherwise fail to perform as required.

PART 2 PRODUCTS

2.1 PANEL MATERIALS

A. Standing Seam Metal Roof Panels

1. Product: AEP Span "Design Span hp", or equal by one of the following:

   a. Metal Sales Manufacturing Corporation.
   b. Morin; a Kingspan Group company.
   c. Centria.

2. Panel Width: 16 inches.

3. Panel Height: 1.75 inches.

4. Metallic-Coated Steel Sheet: Zinc-coated (galvanized) steel sheet complying with ASTM A 653/A 653M, G90 (Z275) coating designation, or aluminum-zinc alloy-coated steel sheet complying with ASTM A 792/A 792M, Class AZ50 (Class

AZM150) coating designation; structural quality. Prepainted by the coil-coating process to comply with ASTM A 755/A 755M.

5. Nominal Thickness: Minimum 24-gauge

6. Narrow Batten Cap: Same color and gauge as panel.

7. Exterior Finish: Two-coat fluoropolymer.

8. Color: AEP Span Cool Hemlock Green, or equivalent by other manufacturer.

B. Low-Slope Metal Roof Panels

1. Product: AEP Span "Span-Lok hp", or equal by one of the following:

   a. Metal Sales Manufacturing Corporation.
   b. Morin; a Kingspan Group company.
   c. Centria.

2. Panel Width: 16 inches with pencil rib striations, two per panel.

3. Panel Height: 2 inches.

4. Metallic-Coated Steel Sheet: Zinc-coated (galvanized) steel sheet complying with ASTM A 653/A 653M, G90 (Z275) coating designation, or aluminum-zinc alloy-coated steel sheet complying with ASTM A 792/A 792M, Class AZ50 (Class AZM150) coating designation; structural quality. Prepainted by the coil-coating process to comply with ASTM A 755/A 755M.

5. Nominal Thickness: Minimum 24-gauge

6. Exterior Finish: Two-coat fluoropolymer.

8. Color: AEP Span Cool Hemlock Green, or equivalent by other manufacturer.

C. Exterior Metal Siding Panel Type 1 - Standing Seam Concealed Fastener Metal Wall Panels:

1. Product: AEP Span "Design Span hp", or equal by one of the following:

   a. Metal Sales Manufacturing Corporation.
   b. Morin; a Kingspan Group company.
   c. Centria.

2. Panel Width: 16 inches.

3. Panel Height: 1.75 inches.

4. Metallic-Coated Steel Sheet: Zinc-coated (galvanized) steel sheet complying with ASTM A 653/A 653M, G90 (Z275) coating designation, or aluminum-zinc alloy-coated steel sheet complying with ASTM A 792/A 792M, Class AZ50 (Class

AZM150) coating designation; structural quality. Prepainted by the coil-coating process to comply with ASTM A 755/A 755M.

5. Nominal Thickness: Minimum 24-gauge

6. Narrow Batten Cap: Same color and gauge as panel.

7. Exterior Finish: Two-coat fluoropolymer.

8. Color: AEP Span Cool Hemlock Green, or equivalent by other manufacturer.

D. Exterior Panel Type 2 – No Reveal Flat Pan Concealed-Fastener Metal Soffit Panels: Formed with vertical panel edges and a raised flat pan no reveal joint between panels.

1. Product: Provide AEP Span Prestige Series, or equal product by one of the following:

   a. Metal Sales Manufacturing Corporation.
   b. Morin; a Kingspan Group company.
   c. Centria.

2. Panel Coverage: 12 inches

3. Panel Height: 1.5 inches.

4. Metallic-Coated Steel Sheet: Zinc-coated (galvanized) steel sheet complying with ASTM A 653/A 653M, G90 (Z275) coating designation, or aluminum-zinc alloy-coated steel sheet complying with ASTM A 792/A 792M, Class AZ50 (Class AZM150) coating designation; structural quality. Prepainted by the coil-coating process to comply with ASTM A 755/A 755M.

5. Nominal Thickness: 0.036 inch (0.86 mm).

6. Exterior Finish: Two-coat fluoropolymer.

7. Color: To be selected by Architect from manufacturer's full range of standard colors.

E. Interior Panel – No Reveal Flat Pan Concealed-Fastener Metal Liner Panels: Formed with vertical panel edges and a raised flat pan no reveal joint between panels.

1. Product: Provide AEP Span Prestige Series, or equal product by one of the following:

   a. Metal Sales Manufacturing Corporation.
   b. Morin; a Kingspan Group company.
   c. Centria.

2. Panel Coverage: 12 inches

3. Panel Height: 1.5 inches.

4. Metallic-Coated Steel Sheet: Zinc-coated (galvanized) steel sheet complying with ASTM A 653/A 653M, G90 (Z275) coating designation, or aluminum-zinc alloy-coated steel sheet complying with ASTM A 792/A 792M, Class AZ50 (Class AZM150) coating designation; structural quality. Prepainted by the coil-coating process to comply with ASTM A 755/A 755M.

5. Nominal Thickness: 0.036 inch (0.86 mm).

6. Exterior Finish: Two-coat fluoropolymer.

7. Color: AEP Span Cool Regal White, or equivalent by other manufacturer.

2.2 ACCESSORIES

A. Miscellaneous Metal Subframing and Furring: ASTM C 645, cold-formed, metallic-coated steel sheet, ASTM A 653/A 653M, G90 (Z275 hot-dip galvanized) coating designation or ASTM A 792/A 792M, Class AZ50 (Class AZM150) aluminum-zinc-alloy coating designation unless otherwise indicated. Provide manufacturer's standard sections as required for support and alignment of metal panel system.

B. Panel Accessories: Provide components required for a complete, weathertight panel system including trim, copings, fasciae, mullions, sills, corner units, clips, flashings, sealants, gaskets, fillers, closure strips, and similar items. Match material and finish of metal panels unless otherwise indicated.

1. Closures: Provide closures at eaves and rakes, fabricated of same metal as metal panels.

2. Backing Plates: Provide metal backing plates at panel end splices, fabricated from material recommended by manufacturer.

3. Closure Strips: Closed-cell, expanded, cellular, rubber or crosslinked, polyolefin-foam or closed-cell laminated polyethylene; minimum 1-inch- (25-mm-) thick, flexible closure strips; cut or premolded to match metal panel profile. Provide closure strips where indicated or necessary to ensure weathertight construction.

C. Flashing and Trim: Provide flashing and trim formed from same material as metal panels as required to seal against weather and to provide finished appearance. Locations include, but are not limited to, bases, drips, sills, jambs, corners, endwalls, framed openings, rakes, fasciae, parapet caps, soffits, reveals, and fillers. Finish flashing and trim with same finish system as adjacent metal panels.

D. Panel Fasteners: Self-tapping screws designed to withstand design loads. Provide exposed fasteners with heads matching color of metal panels by means of plastic caps or factory-applied coating. Provide EPDM or PVC sealing washers for exposed fasteners.

E. Concealed Clips: Galvanized steel, (0.051 inch/16 ga.) (1.29 mm) thick, designed to allow unimpeded thermal movement of wall panel and configured to hold panel minimum (1/2 inch) (12.7 mm) from substrate.

F. Panel Sealants: Provide sealant type recommended by manufacturer that are compatible with panel materials, are nonstaining, and do not damage panel finish.

1. Sealant Tape: Pressure-sensitive, 100 percent solids, gray polyisobutylene compound sealant tape with release-paper backing. Provide permanently elastic, nonsag, nontoxic, nonstaining tape 4 inch (13 mm) wide and 1/8 inch (3 mm) thick.

2. Joint Sealant: ASTM C 920; elastomeric polyurethane or silicone sealant; of type, grade, class, and use classifications required to seal joints in metal panels and remain weathertight; and as recommended in writing by metal panel manufacturer.

3. Butyl-Rubber-Based, Solvent-Release Sealant: ASTM C 1311.

2.3 FINISHES

A. Exposed Coil-Coated Surfaces: Meeting AAMA 2605, two-coat fluoropolymer finish, containing not less than 70 percent PVDF resin by weight in color coat, and containing no PFOA. Prepare, pretreat, and apply coating to exposed metal surfaces to comply with coating and resin manufacturers' written instructions; Arkema Inc. "KYNAR 500" or Solvay Solexis "HYLAR 5000"

B. Concealed Finishes: Minimum 0.15-mil thick corrosion resistant primer with a 0.35-mil off-white backer.

PART 3 EXECUTION

3.1 EXAMINATION

A. Examine the conditions and substrates in which the metal roofing and siding work is to be installed. Do not proceed until unsatisfactory conditions have been corrected.

3.02 INSTALLATION

A. General: Comply with metal panel manufacturer's instructions for assembly, installation, and erection of preformed metal roofing and siding, except where more stringent requirements are indicated.

B. Do not install any component which has defects, including damaged finish, dents, warps, and bends. In order to minimize the potential of damaging the finish coating, do not remove the protective coating or wrapping until the component is ready for installation.

C. Anchor component parts of the preformed metal roofing and siding securely in place, providing for necessary thermal and structural movement.

D. Install panels with sides lapping. Apply sealant to prevent water infiltration.

E. Provide flashings, trim, caps, and accessories in sizes and shapes as indicated or as acceptable to Engineer. Install trim and caps with exposed leg tight against the face of rib.

F. Install metal and flexible closure strips where indicated and where required to prevent air and water infiltration. Provide a continuous bead on the sides of the flexible closure strip where it butts against substrate for a complete air and water seal.

G. Install fasteners as required for complete assembly of the metal panels and the performance intended. Exposed pop-rivets will not be allowed, unless specifically accepted by Engineer. All exposed fasteners shall be spaced evenly and aligned.

H. Prior to driving the screw, brush the steel shavings from the hole for the screw; do not drive screw head down onto steel shavings.

3.3 CLEANING AND PROTECTION

A. Clean exposed surfaces of preformed metal work promptly after completion of installation including removal of strippable coating. Comply with recommendations of both the panel and coating manufacturers.

B. Remove all shavings from the face of panels, and finish surfaces of building; shavings will rust and discolor paint surfaces if not removed.

C. Protection: Protect the preformed metal panels as needed to ensure that the work will be without damage or deterioration at the time of final acceptance.

3.4 REPAIR AND TOUCH-UP

A. Damaged Material: Remove and replace panels and component parts of the work which have been damaged (including finish) beyond successful repair, as determined by the Engineer. Repair minor damage as acceptable to the Engineer.

B. Touch-up-paint all minor damage on the finish coating. Touch-up paint shall be field-applied-type siliconized polyester with exact color, gloss, and appearance match. Touch-up-paint only the actual damaged area with very little overlap to undamaged area.

END OF SECTION

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SECTION 07600 - FLASHING AND SHEET METAL

PART 1 GENERAL

1.1 SUMMARY

A. Section Includes: Flashing and sheet metal work, complete, including, but not necessarily limited to, the following items:

1. Flashing and counterflashings over penetrations for mechanical equipment, vent stacks, etc.

B. Related Sections:

1. Section 07920 – Joint Sealants.

2. Section 09900 – Painting and Coatings: Prime and finish painting.

3. Division 15 - Mechanical: Flashing sleeves and collars for mechanical items protruding through roof.

4. Division 16 – Electrical: Flashing sleeves and collars for electrical items protruding through roof.

1.2 SUBMITTALS

A. Shop Drawings: Submit fully detailed, large-scale shop drawings of all fabricated items. Including all flashing and counterflashings. Describe material profile, jointing pattern, jointing details, fastening methods, and installation details.

1.3 QUALITY ASSURANCE

A. Applicator Qualifications: Company experienced and specializing in sheet metal flashing work.

B. Standards: Conform to the applicable provisions of the "Architectural Sheet Metal Manual", latest edition, as issued by the Sheet Metal and Air Conditioning Contractors' National Association, Inc. (SMACNA).

1.4 DELIVERY, STORAGE, AND HANDLING

A. Stack preformed and prefinished material to prevent twisting, bending, or abrasion, and to provide ventilation.

B. Prevent contact with materials during storage which may cause discoloration, staining, or damage.

PART 2 PRODUCTS

2.1 MATERIALS

A. Galvanized Steel: ASTM A653, G90; 24-gage core steel; minimum 27 percent post-consumer recycled content; typical at all flashings and counterflashings.

B. Elastomeric Flashing: Modified bituminous sheet rubber, self-adhesive-backed rubberized asphalt, in continuous length x widths as required; W.R. Grace "Vycor V40", Johns Manville, or equal. Provide where shown on the Drawings.

C. Screws and Fasteners: Same material as sheet metal or material being fastened; hot-dip galvanized or stainless steel.

D. Solder:

1. For Stainless Steel: ASTM B32; 60 percent tin, 40 percent lead, with acid-chloride type flux, except use rosin flux over tinned surfaces.

2. For Galvanized Steel: ASTM B32; 50 percent tin, 50 percent lead, with rosin flux.

E. Cleats: 2-inch wide x 3-inch long, unless otherwise indicated. Fabricate from same material and gage as sheet metal being installed.

F. Metal Accessories: Provide sheet metal clips, straps, anchoring devices, and similar accessories as required for installation of work, matching or compatible with material being installed, non-corrosive, size and gage as required for performance.

G. Galvanized Repair Paint: Zinc-rich repair paint, Z.R.C., Cold Galvanizing, Tnemec-zinc 92, or equal.

H. Elastomeric Sealant: ASTM C920, polyurethane or silicone sealant, of type and class required to seal joints in sheet metal flashing and trim, and remain watertight.

2.2 FABRICATION

A. Form sections true to shape, accurate in size, square, and free from distortion or defects. Form pieces in longest practical lengths. Seal metal joints with sealant.

1. Cleats and Starter Strips: Fabricate of same material as sheet, minimum 3 inches long, interlockable with sheet.

2. Exposed Edges: Hem on underside 1/2 inch; miter and seam corners. Form material with flat lock and cover plate seam, as shown.

3. Corners: Fabricate from one piece with minimum 24 inch long legs; mechanically fasten and solder watertight.

4. Vertical Faces: Fabricate with bottom edge formed outward 1/4 inch and hemmed to form drip.

5. Counterflashings: Fabricate to allow toe to extend 4 inch minimum over roofing surface. Return and brake edges.

2.3 FINISHES

A. Exposed Surfaces: Comply with NAAMM's "Metal Finishes Manual for Architectural and Metal Products" for applying and designating finishes. Protect prepainted finishes on exposed surfaces with a strippable temporary protective covering.

B. Concealed Surfaces: Where dissimilar metals will contact each other or corrosive substrates, protect against galvanic action by painting with bituminous coating. Apply a minimum of 15 mils dry film thickness.

PART 3 - EXECUTION

3.1 PREPARATION

A. Field measure site conditions prior to fabricating work. Install starter and edge strips, and cleats before starting installation.

3.2 INSTALLATION

A. General: Apply all work to even, smooth, sound, thoroughly clean, and dry surfaces free from defects. Install all work plumb and securely fastened for watertight installation. Provide accessories and other items essential to completion of work, though not specifically shown or specified.

B. Install sheet metal according to recommendations in SMACNA's "Architectural Sheet Metal Manual" and as indicated. Conform to drawing details included in SMACNA manual. Install self-adhesive membrane flashings prior to or in conjunction with sheet metal items as shown on the Drawings.

C. Attachments: In general, confine attachments of sheet metal less than 12 inches wide to one edge only. Space screws or nails evenly and approximately 4 inches apart. Where sheet metal is applied to surfaces other than wood, provide shop drawings to establish locations for sleepers and nailing strips required to secure the work properly.

D. Soldering: Solder metal joints watertight for full metal surface contact. After soldering, wash metal clean with neutralizing solution and rinse with water.

E. Expansion and Contraction: Provide expansion and contraction joints at all sheet metal work. Unless otherwise specified or indicated, make up long straight runs of sheet metal work in 12 foot lengths maximum, and connect together with 3 inch loose-lock slip-type joints, and fill with sealant as specified. For straight runs less than 12 feet but more than 8 feet, make a similar slip-type joint at center of run. Lock and solder seams of intermediate joints between expansion joints.

F. Flashings:

1. Provide flashings, where shown or required, to provide watertight protection; use galvanized sheet metal, unless otherwise indicated on Drawings.

2. Secure flashings in place using concealed fasteners. Use exposed fasteners only in locations approved by Engineer.

3. Fit flashings tightly in place. Make corners square, surfaces true and straight in planes, and lines accurate to profiles.

G. Counterflashings:

1. Provide counterflashings at intersections of roof with vertical surfaces and similar conditions. Secure to vertical surfaces as detailed.

2. Turn down counterflashings over base flashings not less than 4 inches; form to provide a spring action against base flashing or roofing.

3. Overlap joints a minimum of 4 inches and bed with elastomeric sealant. Provide prefabicated end closures.

H. Equipment Support Flashing: Coordinate installation of support flashing and counterflashing with installation of roofing and items. Weld or seal flashing to support members with elastomeric sealant.

END OF SECTION

SECTION 07920 - JOINT SEALANTS

PART 1 GENERAL

1.1 SUMMARY

A. Section Includes: Preparation of sealant substrate surfaces, and providing of sealant and backing materials, complete.

B. Related Sections:

1. Section 08800 - Glazing: Sealants used in conjunction with glazing.

1.2 SUBMITTALS

A. Product Data: Submit product data indicating sealant chemical characteristics, performance criteria, limitations, and color availability for each condition and use. Manufacturer's Data: Submit manufacturer's specifications, recommendations, and installation instructions, including cleaning of joint surfaces, for each type of material required.

B. Samples: Submit samples of each color required for each type of exposed sealant. Samples will be reviewed by Architect for color and texture only. Compliance with all other requirements is the exclusive responsibility of the Contractor.

C. Certificates: Submit manufacturer's certificate that sealants meet or exceed specified requirements.

1.3 QUALITY ASSURANCE

A. Applicator Qualifications: Experienced and specializing in applying the Work of this Section, and approved by sealant manufacturer.

B. Regulatory Requirements: For interior applications use sealants and sealant primers that comply with South Coast Air Quality Management District (SCAQMD) Rule #1168, effective July 1, 2005 and rule amendment date of January 7, 2005. Meet the following VOC limit in grams per liter less water, when calculated according to 40 CFR 59:

1. Architectural Sealants: 250 g/L.

2. Sealant Primers for Nonporous Substrates: 250 g/L.

3. Sealant Primers for Porous Substrates: 775 g/L.

C. Quality Control: Comply with manufacturer's printed instructions for surface preparation, priming, installation, tooling, and curing, except where more stringent requirements are specified.

1.4 PROJECT CONDITIONS

A. Do not install solvent-curing sealants in enclosed building spaces.

B. Weather Conditions: Do not proceed with installation of sealants under adverse weather conditions or when temperatures are below or above manufacturer's recommended limitations for installation. Proceed with the work only when forecasted weather conditions are favorable for proper cure and development of high early bond strength. Wherever joint width is affected by ambient temperature variations, install sealants only when temperatures are in the lower third of manufacturer's recommended installation temperature range.

1.5 WARRANTY

A. Provide ten (10) year warranty. Include coverage of installed sealants and accessories which fail to achieve air-tight and water-tight seal, exhibit loss of adhesion or cohesion, or do not cure.

PART 2 PRODUCTS

2.1 SEALANT MATERIALS

A. General:

1. Compatibility:

a. Before purchase of each required material, confirm its compatibility with every other material to which it will be applied in the joint system.
b. Where more than one sealant material is in contact or potentially in contact with another, provide sealant materials which are compatible with each other.
c. Where specified butyl-rubber sealant is to be in contact with silicone sealant, provide silicone sealant instead of the specified butyl-rubber sealant.
d. Where sealant is in contact with waterproof membranes, provide sealant which is compatible with the membrane and approved by the membrane manufacturer.

2. VOC Content of Interior Sealants: Provide interior sealants and sealant primers that comply with the following limits for VOC content when calculated according to 40 CFR 59:

a. Sealants: 250 g/L.
b. Sealant Primers for Nonporous Substrates: 250 g/L.
c. Sealant Primers for Porous Substrates: 775 g/L.

3. Colors: For concealed material provide any of manufacturer's standard colors; for exposed material provide manufacturer's standard colors as selected by ENGINEER, unless otherwise noted.

B. Exterior Concealed Sealant for Bedding Purposes: Single-component butyl sealant, solvent release, non-skinning, non-sagging; meeting FS TT-S-001657; DAP "Butyl-flex", Bostik "Chem-Calk 300", or equal.

C. Exterior Exposed Joints for General Use: Single-component nonsag polyurethane sealant; meeting ASTM C920, Type S, Grade NS, Class 25; Sika Corporation "Sikaflex-1a/15 LM", Tremco "Dymonic FC", Pecora "Dynatrol I", or equal.

D. Exterior Exposed Joints of Nonporous Substrates (Glass, Metals, etc.): Single-component acid-cure silicone sealant; meeting ASTM C920, Type S, Grade NS, Class 25; Dow Corning "795 Glass and Metal Building Sealant," G.E. "Silpruf," or equal.

E. Horizontal Traffic Joints, Interior or Exterior: Single-component pourable polyurethane sealant, self-leveling, color to match adjacent surfaces or grout color; meeting ASTM C920, Type S, Grade P, Class 25; Tremco "Vulkem 45," Sonneborn "Sonolastic SL 1," or equal.

F. Interior Non-wet, Non-moving Joints: Single-component acrylic emulsion latex, non-staining, non-bleeding, non-sagging; color as selected; meeting ASTM C834; DAP "Acrylic Latex Caulk", Pecora "AC-20", Tremco "Tremflex 834", or equal.

2.2 ACCESSORIES

A. Primer: Non-staining type, VOC compliant, recommended by sealant manufacturer to suit application.

B. Joint Cleaner: Non-corrosive and non-staining type, VOC compliant, recommended by sealant manufacturer; compatible with joint-forming materials.

C. Joint Backing Rod: Preformed; compressible; resilient; non-staining round backer rod; compatible with joint substrates, sealants, and primers; as recommended by sealant manufacturer for type of sealant; oversized 30 to 50 percent larger than joint width; meeting ASTM D1056.

1. Typical Joints: Closed cell polyethylene or polyurethane foam.

2. Horizontal Joints Exposed to Water: Closed cell polyethylene foam, non-absorbent to water, non-outgassing in unruptured state.

D. Bond Breaker: Pressure-sensitive tape recommended by sealant manufacturer to suit application.

PART 3 EXECUTION

3.1 EXAMINATION

A. Examine the substrates and the conditions under which sealant work is to be performed. Do not proceed with the work until unsatisfactory conditions have been corrected.

B. Verify that surfaces and joint openings are ready to receive work and field measurements are as shown on Drawings and recommended by the manufacturer. Start of installation means the condition of existing surfaces has been accepted.

3.2 PREPARATION

A. Clean joint surfaces immediately before installation of sealant. Remove dirt, insecure coatings, moisture, and other substances which could interfere with bond of sealant compound. Etch concrete joint surfaces as recommended by sealant manufacturer. Use cleaning solvent to clean all joint surfaces. Wipe joints free of solvent using clean, dry, white cotton cloths or white, lintless paper. Do not permit solvent to air dry.

B. Prime or seal the joint surfaces. Do not allow primer/sealer to spill or migrate onto adjoining surfaces. All anodized aluminum surfaces to receive sealant shall be primed with primer recommended by the sealant manufacturer, unless sealant manufacturer certifies in writing that primer is not required.

C. Install sealant backer rod for elastomeric sealants, except where shown to be omitted or recommended to be omitted by sealant manufacturer for the application shown, or when backed by other solid substrate.

D. Install bond-breaker tape wherever backer rod is not used and wherever required by manufacturer's recommendations to ensure that elastomeric sealants will perform properly.

E. Verify that joint backing and release tapes are compatible with sealant.

F. Protect elements surrounding the work of this Section from damage or disfiguration.

3.3 INSTALLATION

A. Install sealants in accordance with manufacturer's written instructions, unless more stringent requirements are indicated or specified.

B. Sealant Installation Standard: Comply with recommendations in ASTM C1193 for use of joint sealants as applicable to materials, applications, and conditions indicated.

C. Measure joint dimensions and size materials to achieve required width/depth ratios.

D. Install joint backing to achieve a neck dimension no greater than 1/2 the joint width. Neck dimension to be a minimum 1/4 inch and a maximum 1/2 inch. Install bond breaker where joint backing is not used.

E. Apply sealant within recommended application temperature ranges. Consult manufacturer when sealant cannot be applied within these temperature ranges.

F. Employ only proven installation techniques, which will ensure that sealants will be deposited in uniform, continuous ribbons without gaps or air pockets, with complete "wetting" of the joint bond surfaces equally on opposite sides. Except as otherwise indicated, fill sealant rabbet to a slightly concave surface, slightly below adjoining surfaces. Where horizontal joints are between a horizontal surface and a vertical surface, fill joint to form a slight cove so that joint will not trap moisture and dirt.

G. In exterior work where sealant tape is used, provide cap sealant bead of the specified silicone sealant.

H. Install sealant around all doors, windows and around all observable sources of air leakage from the building.

J. Cure sealants in compliance with manufacturer's instructions and recommendations to obtain high early bond strength, internal cohesive strength, and surface durability.

3.4 CLEANING AND REPAIRING

A. Do not allow sealants or compounds to overflow or spill onto adjoining surfaces or to migrate into the voids of adjoining surfaces. Clean the adjoining surfaces by whatever means may be necessary to eliminate evidence of spillage.

B. Repair or replace defaced or disfigured finishes caused by work of this Section. Protect sealants until cured.

END OF SECTION

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SECTION 08110 - STEEL DOORS AND FRAMES

PART 1 GENERAL

1.1 SUMMARY

A. Section Includes:

1. Non-rated rolled steel doors and frames in standard and non-standard sizes, complete.

2. Vision panel frames, transoms, and accessories for doors as required.

B. Related Sections:

1. Section 08710 - Door Hardware.

2. Section 08800 - Glazing

3. Section 09960 – Painting and

Coatings.

4. Section 13440 – Metal Building Systems

1.2 REFERENCES

A. American National Standards Institute (ANSI):

1. ANSI/SDI A250.6 "Recommended Practice for Hardware Reinforcing on Standard Steel Doors and Frames".

2. ANSI/SDI A250.8 "Recommended Specifications for Standard Steel Doors and Frames".

3. ANSI/SDI A250.11 "Recommended Erection Instructions for Steel Frames".

B. Door and Hardware Institute (DHI): "The Installation of Commercial Steel Doors and Steel Frames, Insulated Steel Doors in Wood Frames and Builder's Hardware".

C. National Fire Protection Association (NFPA):

1. 80 "Standard for Fire Doors and Other Opening Protectives".

D. Steel Door Institute (SDI): SDI 117 "Manufacturing Tolerances for Standard Steel Doors and Frames".

E. Underwriters Laboratories, Inc. (UL):

1. 10B "Fire Tests of Door Assemblies".

2. 10C "Positive Pressure Fire Tests of Door Assemblies".

3. 1784 "Air Leakage Tests of Door Assemblies".

1.3 SUBMITTALS

A. Shop Drawings: Submit shop drawings indicating frame configuration, anchor types and spacings, location of cutouts for hardware, reinforcement, and finish. Show door elevations, internal reinforcement, closure method, and cut outs for glazing.

B. Schedule: Submit schedule showing location of each door and frame assembly.

C. Product Data: Submit manufacturer's product data and specifications on metal doors and frames, and manufacturer's installation instructions.

1.4 QUALITY ASSURANCE

A. Standards:

1. Doors and Frames: Conform to ANSI/SDI A250.8.

2. Installation: Conform to ANSI/SDI A250.11.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Deliver hollow metalwork cartoned or crated to provide protection during transit and job storage. Break seal on-site to permit ventilation.

B. Inspect hollow metalwork upon delivery for damage. Repair and replace damaged items as required.

C. Store hollow metalwork on raised platforms in vertical positions with blocking between units to allow air circulation. Keep stored material covered and protect form damage.

PART 2 PRODUCTS

2.1 MANUFACTURERS

A. Provide metal doors and frames manufactured by Amweld Building Products, Ceco Door Products, Curries Co., Windsor Republic Doors, Steelcraft, or equal.

B. Oversize Doors and Frames: Provide as manufactured by Ambico, Crown Industrial, Stiles, or equal.

2.2 MATERIALS

A. Cold-Rolled Steel Sheets: ASTM A1008, Commercial Steel (CS), Type B; suitable for exposed applications. Provide steel with minimum 27 percent post-consumer recycled content.

B. Hot-Rolled Steel Sheets: ASTM A1011, Commercial Steel (CS), Type B; free of scale, pitting, or surface defects; pickled and oiled. Provide steel with minimum 27 percent post-consumer recycled content.

C. Metallic-Coated Steel Sheets: ASTM A653, Commercial Steel (CS), Type B, with minimum A40 (ZF120) zinc-iron-alloy (galvannealed) metallic coating. Provide steel with minimum 27 percent post-consumer recycled content.

D. Frame Anchors: ASTM A591, Commercial Steel (CS), 40Z (12G) coating designation; mill phosphatized.

1. For anchors built into exterior walls, steel sheet complying with ASTM A1008 or ASTM A1011, hot-dip galvanized according to ASTM A153, Class B.

E. Inserts, Bolts, and Fasteners: Hot-dip galvanized according to ASTM A153.

F. Grout: ASTM C476, except with a maximum slump of 4 inches, as measured according to ASTM C143.

G. Mineral-Fiber Insulation: ASTM C665, Type I (blankets without membrane facing); consisting of fibers manufactured from slag or rock wool with 6- to 12-lb/cu. ft. density; with maximum flame-spread of 25 and smoke-development index; passing ASTM E136 for combustion characteristics.

H. Glazing: Comply with requirements of Section 08800 - Glazing.

I. Bituminous Coating: Cold-applied asphalt mastic, SSPC-Paint 12, compounded for 15-mil dry film thickness per coat, inert-type noncorrosive compound, free of asbestos fibers, sulfur components, and other deleterious impurities.

J. Shop Primer: Manufacturer's standard, fast-curing, lead and chromate-free, complying with ANSI/SDI A250.10 acceptance criteria; compatible with substrate for field-applied coatings despite prolonged exposure.

2.3 STANDARD HOLLOW METAL DOORS AND FRAMES

A. General: Comply with ANSI/SDI A250.8.

B. Hardware Reinforcement: Fabricated according to ANSI/SDI A250.6, with reinforcing plates from same material as door face sheets.

C. Frame Anchors: Minimum 0.053-inch (16-gage) thick steel, as follows:

1. Metal Stud Anchors: Z-type anchor, welded to frame.

2. Masonry Anchors: Adjustable T-strap, corrugated, 2 inch x 10 inch size, perforated and permanently anchored to frame at fire-rated frames.

3. Existing Wall Anchors: 0.053-inch thick pipe spacer with 2-inch x 0.053-inch thick steel plate sized to accommodate a 3/8-inch diameter countersunk flathead expansion anchor.

4. Floor Clip: Adjustable 2-piece angle anchor, full width of frame, 0.067-inch thick steel.

D. Oversize Doors and Frames:

1. Standard: Meeting ANSI/NAAMM Standard HMMA 861 - Specification for Commercial Hollow Metal Doors and Frames. Construct doors and frame to manufacturer□s standard for heavy duty oversized assembly.

E. Glazing Stops in Doors: Minimum 0.032 inch thick, fabricated from same material as door face sheet.

1. Outside of Exterior Doors: Fixed, integral to doors.

2. Secure Side of Doors: Removable, fabricated from same material and gage as door face sheets.

F. Glazing Stops in Frames: Minimum 0.032 inch thick, fabricated from same material as frames, rolled steel channel shape, butted corners; prepared for countersunk style screws.

2.4 FABRICATION

A. Frames: Fabricate as welded unit type.

1. Fabricate with hardware reinforcement plates welded in place.

2. Use concealed connectors, finished to match adjacent members.

3. Provide adjustable clip angles at bottom of frames for proper frame alignment and height adjustment.

4. Door Silencers: Prepare frames for resilient rubber, snap-in type silencers. Drill frames for 3 silencers at single doors on strike side, and for 2 silencers on frame head at double doors without mullions. Omit at rated frames and frames with gasketing.

5. Frames Wider Than 48 Inches: Provide roll-formed steel channels fitted tightly into frame head, flush with top.

B. Doors:

1. Fabricate with hardware reinforcement plates welded in place.

2. Close top edge of exterior doors flush with inverted steel channel closure. Seal joints watertight.

C. Hardware Preparation: Factory prepare hollow metal work to receive templated mortised hardware. Reinforce doors and frames to receive non-templated, mortised and surface-mounted door hardware.

1. Locate hardware according to ANSI/SDI A250.8 *[ANSI/NAAMM-HMMA 861] , unless otherwise indicated.

2. Comply with applicable requirements in ANSI/SDI A250.6 and ANSI/DHI A115 Series specifications for preparation of hollow metal work for hardware.

3. Provide reinforcing, drilling, tapping, and cutouts in accordance with the referenced standards, approved shop drawings, and door and frame schedule. Coordinate locations of conduit and wiring boxes for electrical connections with other Sections.

D. Stops and Moldings: Provide stops and moldings around glazed lites in hollow metal doors, windows, and where indicated. Form corners of stops and moldings with butted or mitered hairline joints.

1. Glazed Lites: Set glazing stops for glazing to be furnished and installed under Section 08800. Provide fixed stops and moldings welded on secure side of hollow metal work. At multiple glazed lites, provide fixed and removable stops and moldings so that each glazed lite is capable of being removed independently.

2. Fixed Stops and Moldings: Form integral with door and frame, unless otherwise indicated. Provide fixed frame moldings on outside of exterior and on secure side of interior doors and frames.

3. Removable Stops and Moldings: Provide on inside of hollow metal work.Secure with screws spaced uniformly not more than 12 inches on center.

a. Material: Not less than 20-gage steel sheets, galvanized for exterior and cold rolled for interior.
b. Fasteners: Phillips head machine screws.

E. Tolerances: Comply with SDI 117 "Manufacturing Tolerances for Standard Steel Doors and Frames".

2.5 FINISH

A. Prime Finish: Manufacturer's standard shop primer, fast-curing, lead and chromate-free, complying with ANSI/SDI A250.10 acceptance criteria; recommended by primer manufacturer for substrate; compatible with substrate and field-applied coatings despite prolonged exposure.

PART 3 EXECUTION

3.1 INSTALLATION

A. General: Install steel doors, frames, and accessories according to shop drawings, manufacturer’s data, and as specified.

B. Frames: Install in accordance with ANSI/SDI A250.11, unless otherwise indicated. Set in place before construction of adjacent masonry or framed walls. Set accurately in position, plumbed, aligned, and braced securely until permanent anchors are set. After wall construction is complete, remove temporary braces and spreaders, leaving surfaces smooth and undamaged.

!. Abutting Frames: Install roll formed steel reinforcement channels between frames. Anchor to structure and floor.

2. Frames in Masonry: Fully grout as work progresses.

6. Frames in Concrete: Where frames are anchored with bolts through the face, fill heads with metal putty, grind smooth, and touch-up prime paint. Grout through keyways provided at head and jambs.

C. Frame Anchors: Coordinate setting of frames with wall construction for wall thickness and anchor placement. Provide anchors as follows:

1. Metal Stud Partitions: Minimum 3 wall anchors per jamb for frames up to 7'-6" high, and an additional anchor for each additional 18 inches. Install adjacent to hinge location on hinge jamb and at corresponding height on strike jamb. Attach to studs with screws.

2. Floor Anchors: One anchor each jamb for interior doors. Where wall construction will not allow placement of floor anchor, provide additional jamb anchor as close to floor as possible.

3. Masonry Walls: Minimum 3 wall anchors per jamb for frames up to 7'-6" high, and an additional anchor for each additional 18 inches. Install adjacent to hinge location on hinge jamb and at corresponding height on strike jamb.

4. Concrete Walls: Minimum 3 completed opening anchors per jamb for frames up to 7'-6" high, and an additional anchor for each additional 18 inches. Install adjacent to hinge location on hinge jamb and at corresponding height on strike jamb. Set frames and secure to adjacent construction with bolts and masonry anchorage devices.

D. Door Installation: Install in accordance with ANSI A250.8. Fit hollow metal doors accurately in frames, within clearances specified in ANSI A250.8. Shim as necessary.

1. Fire Rated Doors: Install within clearances specified in NFPA 80.

2. Smoke Control Doors: Install in accordance with NFPA 105.

E. Coordinate installation of glass and glazing.

3.2 TOLERANCES

A. Maximum Diagonal Distortion: 1/8-inch measured with straight edge, corner to corner.

END OF SECTION

SECTION 08332 - OVERHEAD COILING DOORS

PART 1 GENERAL

1.1 SUMMARY

A. Section Includes: Non-fire resistive insulated motor operated overhead coiling doors.

B. Related Sections:

1. Section 08710 - Door Hardware: Provision of cylinders for door locks and lock-operated push buttons at motor operated doors.

2. Section 09990 – Painting and Coatings: Provision of finish painting of shop primed materials.

3. Section 13340 – Metal Building System.

1.2 REFERENCES

A. International Code Council (ICC).

1. California Building Code (CBC).

B. National Electrical Manufacturers Association (NEMA).

1.3 SYSTEM DESCRIPTION

A. Design Requirements:

1. Compatibility with Space and Service Requirements:

a. Provide items complete including all necessary ancillary equipment as may be required for complete and trouble-free operation.

b. Electrical work under this Section shall be in accordance with Division 16, unless specifically specified otherwise.

2. Maintenance Requirements:

a. Provide each door assembly as complete unit produced or supplied by a single manufacturer, including frames, sections, brackets, operating mechanisms, hardware, except hardware items specified in Section 08710, and all necessary accessories for installation of complete in openings indicated.

b. Unless otherwise specified, all doors of particular type throughout the entire project shall be as manufactured or supplied by a single manufacturer.

1.4 SUBMITTALS

A. Product Data:

1. General: Submit data completely describing products, including rough-in diagrams.

2. Electrical Operators: Submit complete manufacturer's data for all components for electric door operators. Show motor size and characteristics. Show manufacturer's verification that motor has been adequately sized for each size and type of door required. Submit electrical schematic diagrams.

B. Shop Drawings:

1. Drawings showing complete installation details, required clearances, relation to building structure, complete electrical rough-in requirements required for installation of motor operators for doors and for connection of such doors to fire alarm system, referenced to the door mark number.

2. Show location and size of access doors required to perform maintenance on doors and auxiliary equipment.

C. Samples: Submit samples of finishes for finish selection.

D. Quality Control Submittals:

1. Manufacturer's Instructions: Installation instructions for each type and size of door, including manufacturer's data, operating instructions, and maintenance data. Furnish installer copy of diagrams and installation instructions.

E. Contract Closeout Submittals:

1. Project Record Documents:

a. Operation and Maintenance Data: Provide manufacturer's operation and maintenance data for each different type of door specified, complete with manufacturer's list of recommended spare parts and their prices, electrical schematic diagrams and name and address of nearest maintenance organization approved by door manufacturer.

b. Warranty: Provide manufacturer's standard warranty.

1.5 QUALITY ASSURANCE

A. Regulatory Requirements:

1. Wind loading in accordance with 2010 California Building Code. Design for 20 psf wind load.

2. Seismic requirements for door anchorage and support systems in accordance with 2010 California Building Code.

3. Provide electrical materials in NEMA Type enclosures as specified.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Packing, Shipping, and Storage: Protect doors during shipment and storage to prevent warping, bending, and corrosion.

B. Deliver materials only after proper facilities are available. Provide clean dry surfaces or platform as required and protect from deterioration and foreign matter.

1.7 PROJECT CONDITIONS

A. Field Measurements: Field verify all opening dimensions and clearances prior to fabricating doors.

1.8 SEQUENCING AND SCHEDULING

A. Inserts and Anchorages: Furnish inserts and anchoring devices which must be installed in surrounding construction. Provide layout drawings, templates, and directions for installation of anchorage devices. Coordinate delivery with other work to avoid delays.

PART 2 PRODUCTS

2.1 MANUFACTURED UNITS

A. Motor Operated Insulated Steel Overhead Coiling Door:

1. Manufacturers: One of the following, or equal:

a. The Cookson Company, Model " Rolling Insulated Service Door".

b. Wayne-Dalton Corp., Kinnear Division, Model "Thermo-Tite".

2. Curtain:

a. Mounting: Between jamb mounted.

b. Slats:

1) Exterior Slat: Minimum 22 gauge galvanized steel, interlocking flat-faced slats, manufacturer's standard size with ends of alternate slats fitted with metal end locks to hold curtain in alignment.
2) Interior Slat: Minimum 22 gauge galvanized steel.
3) Insulation: 13/16” rigid insulation..

c. Bottom Bar: Fitted with 2 equal sized steel angles minimum 1/8 inch thick, with lift handle and cylindrical lock with housing capable of receiving cylinder as specified in Section 08710 at either end.

d. Weatherstripping:

1) Bottom Bar: Manufacturer's standard vinyl loop-type or solid flexible foam weatherstripping.
2) Door Jambs: Manufacturer's standard vinyl extrusion seals.
3) Hood or Lintel:
a) Hood: Manufacturer's standard waterproofed canvas baffle.

b) Lintel: Manufacturer's standard brush typed.

3. Guides: Formed of roll formed steel channels and angles or structural angles of sufficient depth to provide a groove of adequate depth on each jamb to hold curtain firmly in guides under design wind pressure.

4. Brackets: Steel plate with permanently sealed ball bearings designed to enclose ends of coil and provide support for counterbalance pipe at each end.

5. Barrel and Counterbalance Mechanism: Steel pipe of sufficient size to carry door load with maximum deflection of 0.03 inch per foot of opening width and counterbalanced by helical springs, oil tempered torsion type designed with minimum safety factor of 25 percent safety factor, and having cast iron barrel plugs that anchor springs to tension shaft and pipe.

6. Hood: Fabricated minimum 24 gauge galvanized steel, designed to enclose curtain coil and counterbalance mechanism.

B. Motor Operated Sound Retardant Steel Overhead Coiling Door:

1. Manufacturers: One of the following, or equal:

a. The Cookson Company, Model " Rolling Insulated Service Door ".

2. Curtain:

a. Mounting: Between jamb mounted.

b. Slats:

1) Exterior Slat: Minimum 18 gauge galvanized steel, interlocking flat-faced slats, manufacturer's standard size with ends of alternate slats fitted with metal end locks to hold curtain in alignment.
2) Interior Slat: Galvanized steel, minimum 22 gauge.
3) Insulation: 13/16” rigid insulation with a minimum R-value of 5.3, flame spread index of 10 and a minimum STC rating of 33 when using 18 gauge exterior slat per ASTM E90.

c. Bottom Bar: Fitted with 2 equal sized steel angles minimum 1/8 inch thick, with lift handle and cylindrical lock with housing capable of receiving cylinder as specified in Section 08710 at either end.

d. Weatherstripping:

1) Bottom Bar: Manufacturer's standard vinyl loop-type or solid flexible foam weatherstripping.
2) Door Jambs: Manufacturer's standard vinyl extrusion seals.
3) Hood or Lintel:
a) Hood: Manufacturer's standard waterproofed canvas baffle.
b) Lintel: Manufacturer's standard brush typed.

3. Guides: Formed of roll formed steel channels and angles or structural angles of sufficient depth to provide a groove of adequate depth on each jamb to hold curtain firmly in guides under design wind pressure.

4. Brackets: Steel plate with permanently sealed ball bearings designed to enclose ends of coil and provide support for counterbalance pipe at each end.

5. Barrel and Counterbalance Mechanism: Steel pipe of sufficient size to carry door load with maximum deflection of 0.03 inch per foot of opening width and counterbalanced by helical springs, oil tempered torsion type designed with minimum safety factor of 25 percent safety factor, and having cast iron barrel plugs that anchor springs to tension shaft and pipe.

6. Hood: Fabricated minimum 24 gauge galvanized steel, designed to enclose curtain coil and counterbalance mechanism.

C. Door Operators:

1. Motor Operator: Heavy duty type motor operator.

a. High starting torque type motor having sufficient power to operate the load at an average speed of 1 foot per second.

b. 480 volt, 3 phase operation.

c. Controlled by momentary contact 3-button station marked OPEN, CLOSE, and STOP. Locate as indicated on Drawings.

d. Provide automatic screw-type limit switch to break circuit at termination of travel.

e. Provide gear reducer consisting of high efficiency worm gearing running in an oil bath and a spring set, solenoid operated brake designed to hold the load when power is off.

f. Provide emergency hand chain operator which does not affect the time of the limit switch, to operate the load in case of power failure.

g. Operator to have reversing NEMA Size 1 starter having mechanical and electrical interlocks, properly sized 24 volt control transformer, and other controls necessary for proper operation, completely assembled and wired to a terminal strip to facilitate field wiring of the power source, pushbutton stations and/or other remote devices.

h. All electrical material supplied shall be in NEMA Type 4 enclosures.

i. Provide safety edge to reverse direction of door if obstruction is encountered. Safety edge to be one of the following or equal:

1) The Cookson Company, Model "Edge Detecting System".
2) Wayne-Dalton Corp., Kinnear Division, Model "Electric Safety Edge".

2.2 ACCESSORIES

A. Fasteners: Sizes and types as recommend by reviewed door manufacturer.

2.3 FINISHES

A. Steel and Galvanized Steel: Manufacturer's standard shop prime and factory powder coated finish coat, custom color to match metal wall panels.

PART 3 EXECUTION

3.1 EXAMINATION

A. Verification of Conditions: Examine openings to receive overhead coiling doors and verify:

1. Dimensions and correctness of backing or support conditions.

2. Absence of defects that would adversely affect installation.

B. Do not start work until unsatisfactory conditions are corrected.

3.2 PREPARATION

A. Verify dimensions and design for each opening.

B. Coordinate details with other work supporting or adjoining coiling doors.

C. Furnish fastening devices as required to mount doors properly.

3.3 INSTALLATION

A. Install doors in strict accordance with manufacturer's installation instructions, unless otherwise indicated on the Drawings.

B. Install assemblies plumb, square, and level at their proper elevations and in their proper planes.

C. Securely anchor assemblies to interior face of openings, in manner that provides full opening clearance, perfectly aligned and adjusted for smooth operation.

D. Interface with Other Products: Separate or isolate dissimilar metals with neoprene gaskets, sleeves, or washers, or with an acceptable coating.

3.4 ADJUSTING

A. Verify that door assemblies are securely anchored to structure, guides are perfectly aligned, doors are adjusted for smooth operation.

B. Upon completion of installation, ensure doors are free from warp, twist, or distortion and are lubricated and properly adjusted to operate freely.

3.5 CLEANING

A. Thoroughly clean surfaces of grease, oil, and other impurities.

B. Replace damaged or otherwise disfigured doors with new prior to final acceptance.

3.6 DEMONSTRATION

A. Provide District's maintenance employees with minimum of 8 hours of maintenance instruction.

3.7 PROTECTION

A. Protect installed doors from damage until final acceptance.

END OF SECTION

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SECTION 08349 - METAL SOUND CONTROL DOORS

PART 1 GENERAL

1.1 SUMMARY

A. Section includes:

1. Metal sound control door assemblies.

B. Related Sections:

1. Section 08710 - Door Hardware.

2. Section 08800 - Glazing

3. Section 09990 – Painting and Coatings.

4. Section 13340 – Metal Building Systems

1.2 COORDINATION

A. Coordinate installation of anchorages for sound control door assemblies. Furnish setting drawings, templates, and directions for installing anchorages. Deliver sleeves, inserts, anchor bolts, and items with integral anchors to Project site in time for installation.

1.3 SUBMITTALS

A. Product Data: For each type of product. Include sound ratings, construction details, material descriptions, core descriptions, finishes, and maintenance data to include in maintenance manuals.

B. Shop Drawings: For sound control door assemblies.

1. Include elevations of each door design.

2. Include details of sound control seals, door bottoms, and thresholds.

3. Include details of doors, including vertical- and horizontal-edge details and metal thicknesses.

4. Include frame details for each frame type, including dimensioned profiles and metal thicknesses.

5. Include locations of reinforcements and preparations for hardware.

6. Include details of each different wall opening condition.

7. Include details of anchorages, joints, field splices, and connections.

8. Include details of accessories.

9. Include details of moldings, removable stops, and glazing.

10. Include details of conduits and preparations for power, signal, and control systems.

C. Schedule: Provide a schedule of sound control door assemblies prepared using same reference numbers for details and openings as those on Drawings. Coordinate with the Door Hardware Schedule.

D. Qualification Data: For Installer.

E. Product Certificates: For each type of sound control door assembly.

F. Product Test Reports: For each sound control door assembly, for tests performed by manufacturer and witnessed by a qualified testing agency.

G. Sample Warranty: For manufacturer's special warranties.

1.4 QUALITY ASSURANCE

A. Installer Qualifications: An entity that employs installers and supervisors who are trained and approved by manufacturer.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Deliver doors and frames palletized, wrapped, or crated to provide protection during transit and Project-site storage. Avoid the use of nonvented plastic.

B. Provide additional protection to prevent damage to factory-finished units.

C. Deliver welded frames with two removable spreader bars across bottom of frames, tack welded to jambs and mullions.

D. Store doors and frames vertically under cover at Project site with head up. Place on minimum 4-inch- (102-mm-) high wood blocking. Provide minimum 1/4-inch (6-mm) space between each stacked door to permit air circulation.

1.6 WARRANTY

A. Special Warranty: Manufacturer agrees to repair or replace components of sound control door assemblies that fail in materials or workmanship within specified warranty period.

1. Failures include, but are not limited to, the following:

a. Failure to meet sound rating requirements.

b. Faulty operation of sound seals.

c. Deterioration of metals, metal finishes, and other materials beyond normal use or weathering.

2. Warranty Period: Five years from date of Substantial Completion.

PART 2 PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Sound Rating: Provide sound control door assemblies identical to those of assemblies tested as sound-retardant units by an acoustical testing agency, and have the following minimum rating:

1. STC Rating: Not less than 46 as calculated by ASTM E 413 when tested in an operable condition according to ASTM E 90.

2.2 STEEL SOUND CONTROL DOORS

A. Product: Provide Overly Door Company; SC Series, or equal product by one of the following:

1. Fleming Door Products Ltd.; Assa Abloy Group Company.

2. Krieger Specialty Products Company.

B. Source Limitations: Obtain steel sound control door assemblies, including doors, frames, sound control seals, hinges, thresholds, and other items essential for sound control, from single source from single manufacturer.

C. Doors: Flush-design sound control doors, 1-3/4 inches (44 mm) thick, of seamless construction; with manufacturer's standard sound-retardant core as required to provide STC rating indicated. Construct doors with smooth, flush surfaces without visible joints or seams on exposed faces or stile edges. Fabricate according to NAAMM-HMMA 865.

1. Interior Doors: Fabricate from cold-rolled steel sheet unless otherwise indicated, 0.048-inch (1.21-mm) nominal thickness or thicker as required to achieve STC rating indicated.

2. Core: Manufacturer's standard sound control core.

3. Loose Stops for Glazed Lites in Doors: Same material as face sheets.

4. Top and Bottom Channels: Closed with continuous channels of same material as face sheets, spot welded to face sheets not more than 6 inches (152 mm) o.c.

5. Hardware Reinforcement: Same material as face sheets.

D. Materials:

1. Cold-Rolled Steel Sheet: ASTM A 1008/A 1008M, Commercial Steel (CS), Type B, suitable for exposed applications.

2. Hot-Rolled Steel Sheet: ASTM A 1011/A 1011M, Commercial Steel (CS), Type B; free of scale, pitting, or surface defects; pickled and oiled.

3. Glazing: As required by sound control door assembly manufacturer to comply with sound control requirements.

E. Finishes:

1. Prime Finish: Apply manufacturer's standard primer immediately after cleaning and pretreating.

    a. Shop Primer: Manufacturer's standard, fast-curing, lead- and chromate-free primer complying with SDI A250.10 acceptance criteria; recommended by primer manufacturer for substrate; compatible with substrate and field-applied coatings despite prolonged exposure.

2.3 SOUND CONTROL FRAMES

A. Frames: Fabricate sound control door frames with corners mitered, reinforced, and continuously welded the full depth and width of frame. Fabricate according to NAAMM-HMMA 865.

1. Weld frames according to NAAMM-HMMA 820.

2. Interior Frames: Fabricate from cold-rolled steel sheet unless otherwise indicated, 0.075-inch (1.90-mm) nominal thickness or thicker as required to provide STC rating indicated.

3. Hardware Reinforcement: Fabricate according to NAAMM-HMMA 865 of same material as face sheets.

4. Head Reinforcement: Metallic-coated steel channel or angle stiffener, 0.108-inch (2.74-mm) nominal thickness.

5. Jamb Anchors:

    a. Metal Stud Anchors: Z-type anchor, welded to frame.

    b. Floor Anchors: Not less than 0.079-inch (2.01-mm) nominal-thickness metallic-coated steel.

B. Materials:

1. Cold-Rolled Steel Sheet: ASTM A 1008/A 1008M, Commercial Steel (CS), Type B, suitable for exposed applications.

2. Hot-Rolled Steel Sheet: ASTM A 1011/A 1011M, Commercial Steel (CS), Type B; free of scale, pitting, or surface defects; pickled and oiled.

3. Supports and Anchors: After fabricating, galvanize units to be built into exterior walls according to ASTM A 153/A 153M, Class B.

4. Inserts, Bolts, and Fasteners: Provide items to be built into exterior walls, hot-dip galvanized according to ASTM A 153/A 153M or ASTM F 2329.

5. Powder-Actuated Fasteners in Concrete: Fastener system of type suitable for application indicated, fabricated from corrosion-resistant materials, with clips or other accessory devices for attaching sound control door frames of type indicated.

6. Mineral-Fiber Insulation: Insulation composed of rock-wool fibers, slag-wool fibers, or glass fibers.

C. Finishes:

1. Prime Finish: Apply manufacturer's standard primer immediately after cleaning and pretreating.

a. Shop Primer: Manufacturer's standard, fast-curing, lead- and chromate-free primer complying with SDI A250.10 acceptance criteria; recommended by primer manufacturer for substrate; compatible with substrate and field-applied coatings despite prolonged exposure.

2.4 HARDWARE

A. Sound Control Door Hardware: Manufacturer's standard sound control system, including head and jamb seals, door bottoms, cam-lift hinges, and thresholds, as required by testing to achieve STC rating indicated.

1. Head and Jamb Seals:

a. Silicone Compression Seals: One-piece units consisting of silicone compression bulb and stabilizer flange; attached to door frame adhesively.

2. Door Bottoms: Silicone gasket held in place by metal housing; mortised into bottom edge of door.

3. Cam-Lift Hinges: Full-mortise template type that raises door 1/2 inch (13 mm) when door is fully open; with hardened pin; fabricated from stainless steel.

B. Other Hardware: Comply with requirements in Section 08710 "Door Hardware."

2.5 SOUND CONTROL ACCESSORIES

A. Glazing: Manufacturers' standard factory-installed glazing.

B. Grout: Comply with ASTM C 476, with a slump of not more than 4 inches (102 mm) as measured according to ASTM C 143/C 143M.

C. Corrosion-Resistant Coating: Cold-applied asphalt mastic, compounded for 15-mil (0.4-mm) dry film thickness per coat. Provide inert-type noncorrosive compound free of asbestos fibers, sulfur components, and other deleterious impurities.

2.6 FABRICATION

A. Steel Sound Control Door Fabrication: Sound control doors to be rigid and free of defects, warp, or buckle. Accurately form metal to required sizes and profiles, with minimum radius for thickness of metal.

1. Seamless Edge Construction: Fabricate doors with faces joined at vertical edges by welding; welds shall be ground, filled, and dressed to make them invisible and to provide a smooth, flush surface.

2. Glazed Lites: Factory install glazed lites according to requirements of tested assembly to achieve STC rating indicated. Provide fixed stops and moldings welded on secure side of door.

3. Hardware Preparation: Factory prepare sound control doors to receive templated mortised hardware; include cutouts, reinforcement, mortising, drilling, and tapping.

   a. Reinforce doors to receive nontemplated mortised and surface-mounted door hardware.

   b. Locate door hardware as indicated, or if not indicated, according to NAAMM-HMMA 831, "Recommended Hardware Locations for Custom Hollow Metal Doors and Frames."

4. Tolerances: Fabricate doors to tolerances indicated in NAAMM-HMMA 865.

B. Sound Control Frame Fabrication: Fabricate sound control frames to be rigid and free of defects, warp, or buckle. Accurately form metal to required sizes and profiles, with minimum radius for thickness of metal. Where practical, fit and assemble units in manufacturer's plant. To ensure proper assembly at Project site, clearly identify work that cannot be permanently factory assembled before shipment.

1. Weld flush face joints continuously; grind, fill, dress, and make smooth, flush, and invisible. Where frames are fabricated in sections due to shipping or handling limitations, provide alignment plates or angles at each joint, fabricated from same thickness metal as frames.

2. Provide countersunk, flat- or oval-head exposed screws and bolts for exposed fasteners unless otherwise indicated.

3. Floor Anchors: Weld anchors to bottom of jambs and mullions with at least four spot welds per anchor.

4. Jamb Anchors: Provide number and spacing of anchors as follows:

   a. Locate anchors not more than 18 inches (457 mm) from top and bottom of frame. Space anchors not more than 32 inches (813 mm) o.c. and as follows:

      Two anchors per jamb up to 60 inches (1524 mm) in height.
      Three anchors per jamb from 60 to 90 inches (1524 to 2286 mm) in height.
      Four anchors per jamb from 90 to 96 inches (2286 to 2438 mm) in height.
      Four anchors per jamb plus one additional anchor per jamb for each 24 inches (610 mm), or fraction thereof, more than 96 inches (2438 mm) in height.

5. Head Reinforcement: For grouted frames more than 48 inches (1219 mm) wide, weld continuous head reinforcement to back of frame at head full width of opening.

6. Hardware Preparation: Factory prepare sound control frames to receive templated mortised hardware; include cutouts, reinforcement, mortising, drilling, and tapping.

   a. Reinforce frames to receive nontemplated mortised and surface-mounted door hardware.

b. Locate hardware as indicated, or if not indicated, according to NAAMM-HMMA 831, "Recommended Hardware Locations for Custom Hollow Metal Doors and Frames."

7. Tolerances: Fabricate frames to tolerances indicated in NAAMM-HMMA 865.

PART 3 EXECUTION

3.1 EXAMINATION

A. Examine substrates, areas, and conditions, with Installer present, for compliance with requirements and other conditions affecting performance of the Work.

B. Examine roughing-in for embedded and built-in anchors to verify actual locations of sound control door frame connections before frame installation.

C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

A. Remove welded-in shipping spreaders installed at factory. Restore exposed finish by grinding, filling, and dressing, as required to make repaired area smooth, flush, and invisible on exposed faces.

B. Prior to installation, adjust and securely brace sound control door frames to the following tolerances:

1. Squareness: Plus or minus 1/16 inch (1.6 mm), measured at door rabbet on a line 90 degrees from jamb perpendicular to frame head.

2. Alignment: Plus or minus 1/16 inch (1.6 mm), measured at jambs on a horizontal line parallel to plane of wall.

3. Twist: Plus or minus 1/16 inch (1.6 mm), measured at opposite face corners of jambs on parallel lines, and perpendicular to plane of wall.

4. Plumbness: Plus or minus 1/16 inch (1.6 mm), measured at jambs on a perpendicular line from head to floor.

C. Drill and tap doors and frames to receive nontemplated mortised and surface-mounted door hardware.

3.3 INSTALLATION

A. General: Install sound control door assemblies plumb, rigid, properly aligned, and securely fastened in place; comply with manufacturer's written instructions.

B. Frames: Install sound control door frames in sizes and profiles indicated.

1. Set frames accurately in position; plumbed, aligned, and braced securely until permanent anchors are set. After wall construction is complete, remove temporary braces, leaving surfaces smooth and undamaged.

a. At openings requiring smoke and draft control, install frames according to NFPA 105.

b. Where frames are fabricated in sections due to shipping or handling limitations, field splice at approved locations by welding face joint continuously; grind, fill, and dress; make splice smooth, flush, and invisible on exposed faces.

c. Install sound control frames with removable glazing stops located on secure side of opening.

d. Remove temporary braces only after frames or bucks have been properly set and secured.

e. Check squareness, twist, and plumbness of frames as walls are constructed. Shim as necessary to comply with installation tolerances.

f. Apply corrosion-resistant coating to backs of frames to be filled with mortar, grout, and plaster containing antifreezing agents.

2. Floor Anchors: Provide floor anchors for each jamb and mullion that extends to floor, and secure with postinstalled expansion anchors.

a. Floor anchors may be set with powder-actuated fasteners instead of postinstalled expansion anchors if so indicated and approved on Shop Drawings.

3. Grouted Frames: Solidly fill space between frames and substrate with grout. Take precautions, including bracing frames, to ensure that frames are not deformed or damaged by grout forces.

4. Installation Tolerances: Adjust sound control door frames for squareness, alignment, twist, and plumbness to the following tolerances:

a. Squareness: Plus or minus 1/16 inch (1.6 mm), measured at door rabbet on a line 90 degrees from jamb perpendicular to frame head.

b. Alignment: Plus or minus 1/16 inch (1.6 mm), measured at jambs on a horizontal line parallel to plane of wall.

c. Twist: Plus or minus 1/16 inch (1.6 mm), measured at opposite face corners of jambs on parallel lines, and perpendicular to plane of wall.

C. Plumbness: Plus or minus 1/16 inch (1.6 mm), measured at jambs on a perpendicular line from head to floor.

D. Doors: Fit sound control doors accurately in frames, within clearances indicated below. Shim as necessary.

1. Non-Fire-Rated Doors: Fit non-fire-rated doors accurately in frames with the following clearances:

a. Jambs: 1/8 inch (3 mm).

b. Head with Butt Hinges: 1/8 inch (3 mm).

c. Head with Cam-Lift Hinges: As required by manufacturer, but not more than 3/8 inch (9.5 mm).

d. Sill: Manufacturer's standard.

e. Between Edges of Pairs of Doors: 1/8 inch (3 mm).

E. Sound Control Seals: Where seals have been factory prefit and preinstalled and subsequently removed for shipping, reinstall seals and adjust according to manufacturer's written instructions.

F. Cam-Lift Hinges: Install hinges according to manufacturer's written instructions.

G. Glazing: Comply with installation requirements in Section 088000 "Glazing" and with sound control door assembly manufacturer's written instructions.

1. Secure stops with countersunk flat- or oval-head machine screws spaced uniformly not more than 9 inches (230 mm) o.c. and not more than 2 inches (51 mm) o.c. from each corner.

3.4 FIELD QUALITY CONTROL

A. Testing Agency: Owner will engage a qualified testing agency to perform tests and inspections.

B. Testing Services: Perform testing for verification that assembly complies with STC rating requirements.

1. Acoustical testing and inspecting agency shall select one sound control door(s) at random from sound control door assemblies that are completely installed for testing.

2. Field tests shall be conducted according to ASTM E 336, with results calculated according to ASTM E 413. Acceptable field NIC values shall be within 5 dB of laboratory STC values.

3. Inspection Report: Acoustical testing agency shall submit report in writing to Engineer within 24 hours after testing.

4. If tested door fails, replace or rework all sound control door assemblies to bring them into compliance at Contractor's expense.

a. Additional testing and inspecting at Contractor's expense will be performed to determine if replaced or additional work complies with specified requirements.

C. Prepare test and inspection reports.

3.5 ADJUSTING AND CLEANING

A. Final Adjustments: Check and adjust seals, door bottoms, and other sound control hardware items right before final inspection. Leave work in complete and proper operating condition.

B. Remove and replace defective work, including defective or damaged sound seals and doors and frames that are warped, bowed, or otherwise unacceptable.

   1. Adjust gaskets, gasket retainers, and retainer covers to provide contact required to achieve STC rating.

C. Grouted Frames: Clean grout off sound control door frames immediately after installation.

D. Prime-Coat Touchup: Immediately after erection, sand smooth rusted or damaged areas of prime coat and apply touchup of compatible, rust-inhibitive, air-drying primer.

END OF SECTION

SECTION 08620 - UNIT SKYLIGHTS

PART 1 GENERAL

1.1 SUMMARY

A. Section Includes:

1. Self-flashing unit skylights with integral curbs.

1.2 SUBMITTALS

A. Product Data: For each type of unit skylight.

1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for unit skylights.

B. Shop Drawings: For unit skylight work.

1. Include plans, elevations, sections, details, and connections to supporting structure and other adjoining work.

C. Glazing Samples: For each color and finish of glazing indicated, 12 inches (300 mm) square and of same thickness indicated for the final Work).

D. Product Schedule: For unit skylights. Use same designations indicated on Drawings.

E. Product Test Reports: For each type and size of unit skylight, for tests performed within the last four years by a qualified testing agency. Test results based on testing of smaller unit skylights than specified will not be accepted.

F. Sample Warranty: For special warranty.

1.3 CLOSEOUT SUBMITTALS

A. Maintenance Data: For unit skylights to include in maintenance manuals.

1.4 QUALITY ASSURANCE

A. Manufacturer Qualifications: A manufacturer capable of fabricating unit skylights that meet or exceed performance requirements indicated and of documenting this performance by inclusion in lists and by labels, test reports, and calculations.

B. Installer Qualifications: An installer acceptable to unit skylight manufacturer for installation of units required for this Project.

1.5 WARRANTY

A. Special Warranty: Manufacturer agrees to repair or replace components of unit skylights that fail in materials or workmanship within specified warranty period.

1. Failures include, but are not limited to, the following:

Uncontrolled water leakage.

a. Deterioration of metals, metal finishes, and other materials beyond normal weathering.

b. Yellowing of acrylic glazing.

c. Breakage of polycarbonate glazing.

2. Warranty Period: Five years from date of Substantial Completion.

PART 2 PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Structural Performance, General: Unit skylights shall comply with Cal-OSHA Title 8, Section 3212 (e) (1) without requiring added exterior protection.

B. Unit Skylight Standard: Comply with AAMA/WDMA/CSA 101/I.S.2/A440 for definitions and minimum standards of performance, materials, components, accessories, and fabrication unless more stringent requirements are indicated.

1. Performance Class and Grade: Class CW-PG 40.

2. Certification: AAMA-, WDMA-, or CSA-certified unit skylights with label attached to each.

3. Self-Ignition Temperature: 650 deg F (343 deg C) or more for plastic sheets in thickness indicated when tested according to ASTM D 1929.

4. Smoke-Production Characteristics: Smoke-developed index of 450 or less when tested according to ASTM E 84, and smoke density of 75 or less when tested according to ASTM D 2843

5. Burning Characteristics: Tested according to ASTM D 635. Class CC2, burning rate of 2-1/2 inches (64 mm) per minute or less for nominal thickness of 0.060 inch (1.5 mm) or thickness indicated for use.

C. Thermal Transmittance: NFRC 100 maximum U-factor of 0.22 Btu/sq. ft. x h x deg F.

D. Solar Heat-Gain Coefficient (SHGC): NFRC 200 maximum SHGC of 0.57.

2.2 UNIT SKYLIGHTS

A. General: Provide factory-assembled unit skylights that include glazing, extruded-aluminum glazing retainers, gaskets, and inner frames and that are capable of withstanding performance requirements indicated.

B. Product: Sunoptics; Signature Series Dome (S1), or equal by one of the following:

1. Bristolite Daylighting Systems.

2. O'Keeffe's.

3. Velux America.

4. Wasco Products.

C. Unit Shape and Size: As indicated.

D. Acrylic Glazing: ASTM D 4802, thermoformable, monolithic sheet, category as standard with manufacturer, Finish 1 (smooth or polished), Type UVF (formulated with UV absorber).

E. Polycarbonate Glazing: Manufacturer's standard polycarbonate sheet.

1. Thickness: Not less than thickness required to exceed performance requirements.

2. Color: High-white prismatic.

F. Glazing Gaskets: Manufacturer's standard EPDM, partially vulcanized butyl tape, or liquid-applied elastomeric sealant.

G. Integral Curb: Extruded-aluminum, self-flashing type.

1. Extruded-Aluminum Shapes: ASTM B 221 (ASTM B 221M), alloy and temper to suit structural and finish requirements but with not less than the strength and durability of Alloy 6063-T52.

2. Height: As indicated, not less than 8 inches above highest point of surrounding roofing.

3. Construction: Double wall.

4. Insulation: Manufacturer's standard rigid or semirigid type.

H. Thermal Break: Fabricate unit skylights with thermal barrier separating exterior and interior metal framing.

2.3 ACCESSORY MATERIALS

A. Fasteners: Same metal as metal being fastened, nonmagnetic stainless steel, or other noncorrosive metal as recommended by manufacturer. Finish exposed fasteners to match material being fastened.

1. Where removal of exterior exposed fasteners might allow access to building, provide nonremovable fastener heads.

B. Bituminous Coating: Cold-applied asphalt mastic, compounded for 15-mil (0.4-mm) dry film thickness per coat.

PART 3 EXECUTION

3.1 EXAMINATION

A. Examine openings, substrates, structural support, anchorage, and conditions, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

A. Coordinate installation of unit skylights with installation of substrates, vapor retarders, roof insulation, roofing membrane, and flashing as required to ensure that each element of the Work performs properly and that combined elements are waterproof and weathertight.

B. Comply with recommendations in AAMA 1607 and with manufacturer's written instructions for installing skylights.

C. Install skylights level, plumb, and true to line, without distortion.

D. Anchor skylights securely to supporting substrates.

E. Sway-brace and suspend interior components of tubular skylights according to manufacturer's installation instructions and seismic conditions of Project.

F. Where aluminum surfaces of skylights will contact another metal or corrosive substrates, such as preservative-treated wood, apply bituminous coating on concealed metal surfaces or provide other approved permanent separation recommended in writing by unit skylight manufacturer.

3.3 CLEANING

A. Clean exposed skylight surfaces according to manufacturer's written instructions. Touch up damaged metal coatings and finishes.

B. Remove excess sealants, glazing materials, dirt, and other substances.

C. Remove and replace glazing that has been broken, chipped, cracked, abraded, or damaged during construction period.

D. Protect skylight surfaces from contact with contaminating substances resulting from construction operations.

END OF SECTION

SECTION 08710 - DOOR HARDWARE

PART 1 GENERAL

1.1 THE REQUIREMENT

A. Section Includes:

1. All necessary door hardware to complete the Project, except those items specifically mentioned to be furnished by other Sections.

2. Wherever items of door hardware are not definitely specified but are required for proper completion and/or operation of doors, or a hardware item may no longer be available, furnish hardware in type, quality, and finish suitable for the service required and comparable to that specified for similar conditions, and notify the Engineer immediately.

1.2 RELATED WORK SPECIFIED ELSEWHERE

1. Section 08110, Steel Doors and Frames

2. Section 08349, Metal Sound Control Doors

1.3 REFERENCE SPECIFICATIONS, CODES AND STANDARDS

A. Builders Hardware Manufacturers' Association (BHMA).

B. Door and Hardware Institute (DHI).

C. National Association of Architectural Metal Manufacturers (NAAMM).

D. National Fire Protection Association (NFPA):

1. NFPA 80 - "Fire Doors and Windows".

2. NFPA 101 - "Life Safety Code".

1.4 SUBMITTALS

A. Hardware Schedule: Submit a complete schedule of door hardware for review. Reference items clearly to groups specified, door-type designations shown, location, and other pertinent data. Verify suitability, function, thickness of members, or other factors affecting appropriate selection. List manufacturer's names or suitable abbreviation to facilitate reviewing, opposite each item scheduled.

1. List only readily obtainable hardware that appears in current catalogs. Do not deliver hardware until schedule has been accepted by the Engineer.

2. After the hardware schedule is accepted by the Engineer, provide one copy of the accepted hardware schedule to each trade whose work may be affected.

B. Product Data: Submit catalog cuts and product data on each different type of hardware included in hardware schedule. Indicate locations and mounting heights of each type of hardware. Submit manufacturer's parts lists, templates, and installation instructions.

C. Samples: Prior to delivery of any hardware to the site, submit one sample of each class or type of hardware to the Engineer for final review. Affix labels to fully identify manufacturer, class or type, and location on the Project. After review, accepted samples may be obtained from the Engineer for installation on the Project, providing such samples are picked up within seven days of notification of acceptance.

D. Operation and Maintenance Data: Submit operation and maintenance data. Include data on operating hardware, lubrication requirements, and inspection procedures related to preventative maintenance.

1.5 QUALITY ASSURANCE

A. Supplier Qualifications: Company experienced and specializing in supplying commercial door hardware. The hardware supplier shall employ a member of the Door Hardware Institute (DHI) who is a Certified Architectural Hardware Consultant (AHC) to prepare the hardware schedule submittal and, upon completion of the building, check the installation and disclose any misapplication of hardware.

B. Regulatory Requirements:

1. Egress Doors: Comply with CBC Section 1008 and applicable requirements of NFPA 101 "Life Safety Code".

1.6 DELIVERY, STORAGE, AND HANDLING

A. Deliver hardware with items packed separately, complete and ready for installation with necessary fittings, trim, fasteners, and accessories. Mark packages clearly for identification in accordance with Hardware Schedule. Deliver hardware so that work may progress without delay or interruption.

B. Package all items of hardware and each lockset, latchset, exit device, and door control/closer in its individual package marked with manufacturer's name, type number, and name of item. Furnish each item complete with necessary fastenings, wrenches, spanners, installation instructions, and templates. Indelibly, legibly, and carefully mark each package with an item number corresponding to the door number and hardware group number as indicated on the opening schedule, the approved door Hardware Schedule, and the Drawings and details.

C. Protect hardware from damage before, during, and after installation.

1.7 COORDINATION

A. Coordinate work of this Section with other directly affected Sections involving manufacturer of any internal reinforcement for door hardware.

B. Manufacture all hardware to template. Provide templates and, if necessary, the physical hardware to fabricator of doors and frames in ample time to facilitate the work.

C. Coordinate electrical and security requirements of hardware items with related sections.

1.8 WARRANTY

A. Provide extended warranty for the following hardware items in accordance with requirements of Division 1. Warrant that hardware shall be free of defects in material and workmanship and that it will not deteriorate excessively, or otherwise fail to perform as required.

1. Hinges: Life of building.

2. Door Closers: Ten years.

3. Locks: Five years.

1.9 MAINTENANCE MATERIALS

A. Provide special wrenches and tools applicable to each different or special hardware component.

B. Provide maintenance tools and accessories supplied by hardware component manufacturer.

PART 2 PRODUCTS

2.1 MANUFACTURERS

A. General: Numbers in Hardware Schedule refer to those of the first named manufacturer below. Equivalent products by the other named manufacturers are also acceptable, or equal.

B. Butt Hinges: Stanley (STA), Hager, Lawrence, McKinney.

C. Pivots: Rixson (RIX), Dor-O-Matic.

D. Locksets and Latchsets: Schlage (SCH).

E. Aluminum Door Locks: Adams Rite (AR).

F. Cylinders: Schlage (SCH).

G. Exit Devices: Von Duprin (VON), Precision Hardware Inc.

H. Overhead Closers: LCN, Dorma, Norton.

I. Flush Bolts and Coordinators: Ives (IVE), Door Controls Inc.

J. Stops: Ives (IVE), Trimco.

K. Gasketing and Thresholds: Pemko (PEM), Reese, Zero.

L. Protection Plates and Push/Pull Plates: Ives (IVE), Trimco.

2.2 HINGES

A. Standard: Meeting ANSI A156.1, Grade 1.

B. Type: Butt hinges of the five-knuckle, full mortise type, minimum of two bearings, stainless steel pins, and as follows:

1. Outswinging Doors:

a. To the Exterior: Stainless steel or non-ferrous material, with nonremovable pins (NRP) of the setscrew type.

C. Hinge Size:

1. Doors 1-3/4" thick and up to 37" wide: 4-1/2 x 4-1/2 inch butt hinges provided with at least two ball bearings or life-span bearings.

2. Doors over 1-3/4" thick or over 37" wide: 5 x 4-1/2 inch extra-heavy duty butt hinges provided with at least four ball bearings.

3. Butt hinges for doors thicker than noted above or with unusual trim conditions which would interfere with the full opening of the door shall be provided with hinges of sufficient size to adequately support the door weight and of sufficient width to clear adjacent trim.

D. Number of Hinges Per Door Leaf:

1. Doors up to 60 Inches High: Two hinges per door leaf.

2. Doors up to 90 Inches High: Three hinges per door leaf.

3. Doors over 90 Inches High: Three hinges plus one additional butt hinge for each additional 30 inches in height over 90 inches, or fraction thereof.

2.3 LOCKSETS, LATCHSETS, AND CYLINDERS

A. Standards:

1. Cylindrical Locks: Meeting ANSI A156.2, Series 4000, Grade 1.

B. Lock Type: Where locksets or latchsets are scheduled, provide Schlage "ND" Series, cylindrical type locks, with backsets of 2-3/4 inches, unless otherwise noted. Provide all locks for the entire Project from the same manufacturer.

C. Design: Lever handles, Schlage "Rhodes" design, unless otherwise noted.

D. Strikes: Provide each lockset, latchset, or deadlock with a strike and a strike box. Provide standard type strikes with extended lips where required to protect adjacent trim from being marred by latch bolt. Verify cutout types provided in metal frames.

E. Construction Cylinders: Provide construction keying for cylinders as required and keys for use during construction. Remove construction plugs upon completion of project,

allowing Owner to use final keyed cores.

2.4 DOOR CLOSERS

A. Standards: Meeting ANSI A156.4, Grade 1, and 2000 UBC Standard 7-2 - positive pressure test.

B. Type: Rack and pinion construction, steel spring, fully hydraulic action, non-handed, cast iron or cast aluminum body, non-gumming, non-freezing hydraulic fluid requiring no seasonal adjustment for temperature.

C. Closer Force: Capable of having spring force increased by 50 percent by adjustment without removing from the door, and effecting a maximum operating pressure on the door as follows:

1. Interior Doors: 5.0 pounds.

2. Exterior Doors: 8.5 pounds.

3. Fire Doors: 15 pounds.

D. Overhead Surface-Mounted Closers:

1. Out-swinging Doors to the Exterior and into Corridors: Parallel arm closers, with the closer mounted on the inside of the door.

E. Features: Positive back-check action near the outer limit of the opening cycle, properly located so as to protect door, frame, trim, and hardware; separate adjustments for latch speed, general speed, and back check; hydraulic regulation by tamperproof, noncritical screw valves adjustable only with a hex wrench. Where called for, provide closers with built-in positive stop.

2.5 AUXILIARY HARDWARE

A. Standards: Meeting ANSI A156.16.

B. Door Stops: Floor type or wall bumper type as scheduled. Provide each door leaf with a stop of proper size and height to prevent door from hitting wall or fixed objects. Built-in stops in door closers and overhead stops, where called for, shall satisfy this requirement.

1. Wall Stops: No visible fasteners.

2. Floor Stops: Of height required by floor conditions, fastened by means of machine screws and expansion anchors.

C. Silencers: Gray rubber, non-marring configuration for metal or wood doors. Provide each door with a pressed-metal frame with tamper resistant rubber silencers. Provide each single door with three silencers, each pair of doors with four. Omit at doors to receive gasketing.

2.6 THRESHOLDS, DOOR BOTTOMS, AND GASKETING

A. Provide as scheduled and detailed. Install with countersunk, flat-head screws, of same material and finish as item being attached at all applied thresholds, door bottoms, stops, and door gasketing.

2.7 DOOR PLATES

A. Standards: Meeting ANSI A156.6.

B. Protection Plates: Stainless steel, with beveled edges, as scheduled and detailed.

1. Thickness: Minimum of 0.050-inch.

2. Width: Protection plates shall be 1-1/2-inch less than door width at single doors, 1-inch less than leaf width at pairs of doors.

3. Height: Kickplates shall be 10 inches high. At surface-applied drop seal conditions, extend kickplate from top of drop seal to 12 inches above finished floor.

C. Combination Push-Pull Plates: Minimum 0.050-inch thick, stainless steel, beveled edges.

D. Install plates using countersunk spanner-type stainless steel #6 oval head screws.

2.8 KEYS AND KEYING

A. Meet with Owner to determine final keying requirements. Key the building to match Owner's existing system, as directed by Owner.

B. Key Type: Schlage 6-pin non-removable core system.

C. Number of Keys: 8 keys.

D. Grand Master Key (Opens every door): 4 keys.

E. Identification: Emboss face of each cylinder plug and key with minimum 3-digit visual key control system. Stamp all keys "DO NOT DUPLICATE".

F. Coordinate with Owner the changeover to permanent cores at completion of Project.

G. Provide a construction keying system for Contractor's and/or Owner's use as required during construction. Remove temporary construction plugs upon completion of construction.

2.9 FINISHES

A. Typical Hardware:

1. Typical Interior Locations: BHMA 626 or 652 (US26D) – dull chromium-plated, unless noted otherwise.

2. Exterior Locations: BHMA 630 (US32D) – satin stainless steel, unless otherwise

noted.

B. Thresholds: BHMA 719 – mill finish extruded aluminum.

C. Weatherstripping and Gasketing: BHMA 628 (US28), clear anodized aluminum, unless otherwise noted.

PART 3 EXECUTION

3.1 EXAMINATION

A. Examine doors, frames, and other surfaces to receive door hardware and report all defects which might adversely affect the installation or function of the hardware. Do not begin installation until unsatisfactory conditions have been resolved.

B. Coordinate and be responsible for the proper fabrication of all work or material to receive hardware. No extra cost will be allowed because of changes or corrections necessary to facilitate the proper installation and operation of the hardware.

3.2 INSTALLATION

A. Install hardware in accordance with manufacturer's instructions and requirements of ANSI/NFPA 80, and DHI. Use templates provided by hardware item manufacturer.

B. Accessibility: Conform to CBC and ADAAG requirements for positioning and installing hardware.

C. Hardware: Provide with all necessary screws, bolts, and other devices or fastenings of suitable size and type to secure the hardware in position for heavy use and long life, harmonizing as to material and finish. Furnish fasteners, where necessary, with expansion shields or other approved anchors according to the material to which it is applied and as recommended by the manufacturer. Secure hardware to concrete with expansion sleeve anchors as indicated by best current practice; plastic or "Rawl" plugs will not be accepted. Provide full-threaded hardware screws of sufficient length to firmly engage backing. Screws shall have "Phillips" heads, finished to match hardware.

D. Thresholds: Set in bead of sealant.

E. Keying: Coordinate with the Owner the changeover to permanent cores at completion of Project.

3.3 MAINTENANCE RELATED ITEMS

A. Furnish one set of installation and adjusting tools and one set of maintenance manuals for locksets, exit devices, door controls/ closers, and floor hinges to the Owner.

3.4 ADJUSTMENTS AND INSPECTION

A. Closers: Regulate and adjust to comply with fire and accessibility requirements prior to final inspection.

B. During the installation of hardware a periodic inspection shall be made by the

Contractor in company with a representative of the Engineer and the hardware supplier or his agent. Remove and reinstall hardware improperly installed, at no additional cost to Owner. At completion of the work a final inspection shall be made by the above parties. Make adjustments recommended by any of the above parties.

3.5 HARDWARE SCHEDULE

A. General: The accompanying Hardware Schedule is furnished for whatever guidance and assistance it may afford the Contractor but shall not necessarily be considered as entirely inclusive. Examine the Drawings and the Specifications to determine the extent, quality, and function of hardware required. Furnish all necessary architectural finish hardware to complete the work.

B. Should any door or item be inadvertently omitted from the scheduled hardware, provide such door or item with the same hardware as required for similar purposes. Should it be determined that the hardware scheduled is not suitable due to detail or size of member, provide hardware of proper size, type and function, similar in operation and equivalent to that specified.

C. Whether listed or not, provide latching lockset, door closer, and smoke gasketing at all fire-labeled doors.

3.6 DOOR HARDWARE SCHEDULE

MFR	QUAN	ITEM	NUMBER	FINISH
HARDWARE GROUP 1 (Exterior HM Exit Doors)				
STA	1-1/2	Pr. Butts	FBB199 x NRP, 4-1/2 x 4-1/2	630
VON	1	Exit Device	9875L	630
BEST	1	Cylinder	1E-74	626
Stanley	1	Closer	D4550 HCS SRI	689
PEM	1	Threshold	170A	719
PEM	1	Weatherstrip	303AS	719
GJ	1	Lock Protector	LP1	630
PEM	1	Door Bottom	2211AV	719
IVE	1	Floor Stop	FS17	626
HARDWARE GROUP 2 (Exterior Overhead Door)				
BEST	1	Padlock	41B-722L PREM	626
		Note: Balance of Door Hardware by Overhead Door Contractor		
HARDWARE GROUP 3 (Pr. Exterior HM Doors)				
STA	3	Pr. Butts	FBB199 x NRP, 4-1/2 x 4-1/2	630
VON	1	Exit Device	9875L	630
BEST	1	Cylinder	1E-74	626
GJ	1	Set Auto Flush Bolts	FB31P	626
GJ	1	Dustproof Strike	DP1	626

GJ	1	Coordinator	COR-2 x Filler Bar	626
Stanley	2	Closers	D4550 HCS SRI	689
PEM	1	Threshold	170A	719
PEM	1	Weatherstrip	303AS	719
PEM	1	Astragal	355CS	628
PEM	2	Door Bottoms	2211AV	719
IVE	2	Floor Stop	FS17	626

HARDWARE GROUP 4 (Exterior HM Sound Control Door)

VON	1	Exit Device	9875L	630
BEST	1	Cylinder	1E-74	626
Stanley	1	Closer	D4550 HCS SRI	689
PEM	1	Door Shoe/Drip	216AV	719
GJ	1	Lock Protector	LP1	630
IVE	1	Floor Stop	FS17	626

Note: Remainder of hardware by door and frame manufacturer.

HARDWARE GROUP 5 (Interior HM Sound Control Door)

BEST	1	Cylinder	1E-74	626
IVE	1	Wall Stop	WS406CCV	626

Note: Remainder of hardware by door and frame manufacturer.

HARDWARE GROUP 6 (Interior HM Door)

STA	3	Pr. Butts	FBB199 x NRP, 4-1/2 x 4-1/2	630
BEST	1	Cylinder	1E-74	626
IVE	1	Wall Stop	WS406CCV	626
IVE	3	Silencers	SR64	B

HARDWARE GROUP 7 (Exterior HM Doors)

STA	1-1/2	Pr. Butts	FBB199 x NRP, 4-1/2 x 4-1/2	630
BEST	1	Cylinder	1E-74	626
Stanley	1	Closer	D4550 HCS SRI	689
PEM	1	Threshold	170A	719
PEM	1	Weatherstrip	303AS	719
GJ	1	Lock Protector	LP1	630
PEM	1	Door Bottom	2211AV	719
IVE	1	Floor Stop	FS17	626

-END OF SECTION-

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SECTION 08800 – GLAZING

PART 1 GENERAL

1.1 SUMMARY

A. Section Includes: Glass and glazing accessories for steel frame fixed windows and glazed lites in steel doors.

B. Related Sections:

1. Section 07920 – Joint Sealants

2. Section 08110 – Steel Doors and Frames

3. Section 08349 – Metal Sound Control Doors

1.2 REFERENCES

A. American National Standards Institute (ANSI) Z97.1 - Glazing Material Used in Buildings - Safety Performance Specifications and Methods of Test.

B. ASTM International (ASTM):

1. C 920 - Elastomeric Joint Sealants.

2. C 1036 - Flat Glass.

3. C 1048 - Heat-Treated Flat Glass-Kind HS and Kind FT, Coated and Uncoated Glass.

4. C 1281 - Preformed Tape Sealants for Glazing Applications.

5. C 1376 - Pyrolitic and Vacuum Deposition Coatings on Glass.

6. E 774 - Classification of the Durability of Sealed Insulating Glass Units.

C. Glass Association of North America (GANA) - "Glazing Manual", and "Sealant Manual".

D. Insulating Glass Manufacturers Alliance (IGMA) - SIGMA TM-3000: Glazing Guidelines for Sealed Insulating Glass Units.

1.3 SUBMITTALS

A. Product Data: Submit product data indicating structural, physical and environmental characteristics, size limitations, special handling or installation requirements.

B. Samples: Submit two samples, 6 x 6 inches in size, illustrating each type of glazing unit.

C. Certification: Submit certification that glazing materials used on the Project conform to all applicable requirements of CSPE "Safety Standard for Architectural Glazing Materials", and the requirements of the California Building Code.

1.4 QUALITY ASSURANCE

A. Regulatory Requirements:

1. Comply with 2016 California Building Code (CBC), Chapter 24, "Glass and Glazing."

2. Safety Glazing: Comply with ANSI Z97.1 and testing requirements of Consumer Products Safety Commission (CPSC) "Safety Standard for Architectural Glazing Materials, 16 CFR Part 1201, Category II".

a. Tempered Glass: Identify type and thickness, permanently etched in the glass surface and located on a corner so as to be visible after the glass is installed.

B. Glazing Standards: Comply with recommendations of the following, except where more stringent requirements are indicated:

1. Glass Association of North America (GANA) "Glazing Manual" and "Sealant Manual" for glazing installation methods.

2. Sealed Insulating Glass Manufacturers Association (SIGMA) TM-3000 "Vertical Glazing Guidelines".

C. Insulating Glass Certification Program: Provide insulating glass units permanently marked with appropriate Insulating Glass Certification Council (IGCC) certification label.

PART 2 PRODUCTS

2.1 GLASS MATERIALS

A. Clear Float Glass: ASTM C 1036, Type I - Transparent, Class 1 - Clear, Quality q3 - Glazing select, 1/4-inch thick, unless otherwise noted; Guardian Industries, Fresno, California, or equal.

B. Clear Tempered Float Glass: ASTM C1036-85, Type I, Class 1, Quality q3; tempered where shown and required in accordance with ASTM C1048, Kind FT - Fully Tempered, Condition A - Uncoated surfaces; 1/4-inch thick. Provide where required for safety glazing.

C. Insulating Glass: 1-inch thick sealed insulating glass units, tempered where required.

1. Standard: Comply with ASTM E 774, Class A, and Insulating Glass Manufacturers Alliance Document SIGMA TM-3000.

2. Manufacturer/Type: Guardian Industries, Fresno, California "SunGuard SuperNeutral SN68 CrystalGray", Viracon "Solarscreen 2000 Low-E Insulating Glass", or PPG.

3. Outer Lite: 1/4-inch thick clear glass, low-e coating on #2 face: Guardian VE 1-2M #2.

4. 1/2-inch air space, consisting of the following:

   a. Sealing System: Dual seal with polyisobutylene primary seal and silicone secondary seal, black color.
   b. Spacer material: Manufacturer's standard metal, black color.
   c. Dessicant: Manufacturer's standard; either molecular sieve or silica gel, or a blend of both.

5. Inner Lite: 1/4-inch thick clear float glass.

6. Solar Heat Gain Coefficient: 0.30.

7. Visible Light Transmittance: 49 percent.

2.2 GLAZING ACCESSORIES

A. Elastomeric Glazing Sealant for Nonporous Substrates: Silicone type, meeting ASTM C 920, Type S, Grade NS, Class 25, medium modulus, neutral cure; color to be selected by Architect; Dow Corning "795", G.E. "Silglaze II SCS2800 Sealant", or equal.

B. Setting Blocks: Closed cell preformed silicone or neoprene rubber, complying with ASTM C 509; 80-90 Shore "A" durometer hardness; size as required to set glass properly. Where glazing block is in contact with silicone sealant, provide silicone glazing block compatible with the silicone sealant.

C. Spacer Shims: Silicone or neoprene elastomeric blocks or continuous extrusions; 50-80 Shore "A" durometer hardness; size as required to set glass properly.

D. Glazing Tape: Preformed butyl-polyisobutylene compound 10-15 Shore A durometer hardness; coiled on release paper; size as required to set glass properly; black color; Presstite, Hapco, or equal.

E. Glazing Clips: Manufacturer's standard type.

2.3 FABRICATION

A. Glazing channel dimensions as shown are intended to provide for necessary minimum bite on the glass, minimum edge clearance, and adequate sealant thickness, with reasonable tolerances. Correctly size the glass for each opening, within the tolerances and necessary dimensions established.

B. Factory-label each pane of glass; do not remove labels until final acceptance is obtained.

C. Tong marks on tempered glass shall not be permitted; use horizontal tempering process.

PART 3 EXECUTION

3.1 INSTALLATION

A. Comply with combined recommendations of glass manufacturer and manufacturer of sealants and other materials used in glazing, except where more stringent requirements are shown or specified.

B. Install setting blocks of proper size in sill rabbet; locate at one-fourth of glass width, measured from each jamb.

C. Provide spacers inside and out and of proper size and spacing for glass sizes larger than 50 united inches, except where preshimmed tape or gaskets are used for glazing. Provide 1/8-inch minimum bite of spacers on glass and use thickness equal to sealant width, except with butyl-rubber sealant tape, use thickness 1/32-inch less than final compressed thickness of tape.

D. Prevent exudation of sealant or compound by forming voids or installing filler rods in channels at heel of jambs and heads (do not leave voids in sill channels), except as otherwise indicated.

E. Force sealants into channel to eliminate voids and to ensure complete "setting" or bond of sealant to glass and channel surfaces.

F. Tool exposed surfaces of sealant to provide a substantial "wash" away from the glass. Where pressurized tape is used for exterior glazing, provide silicone cap bead sealant; no portion of tape shall be exposed to weather.

G. Clean and trim excess glazing materials from the glass and stops of frames promptly after installation and eliminate stains and discolorations.

END OF SECTION

SECTION 09110 - NON-STRUCTURAL METAL FRAMING

PART 1 GENERAL

1.1 SUMMARY

A. Section Includes:

1. Non-load-bearing steel framing systems for interior gypsum board assemblies.

1.2 SUBMITTALS

A. Product Data: For each type of product.

PART 2 PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Structural Design: Comply with ASTM C 754 and as follows.

1. Deflection: For wall assemblies, limited to 1/240 of the wall height or 1/2 inch, whichever is less, based on horizontal loading of 5 lbf/sq. ft. (239 Pa)

2. For assemblies with irregular configurations and for long spans, engineer stud assemblies to support related work.

2.2 FRAMING SYSTEMS

A. Framing Members, General: Comply with ASTM C 754 for conditions indicated.

1. Steel Sheet Components: Comply with ASTM C 645 requirements for metal unless otherwise indicated.

2. Protective Coating: ASTM A 653/A 653M, G40 (Z120), hot-dip galvanized unless otherwise indicated.

a. Provide G60 (Z180) at unconditioned spaces and on Z-shaped furring.

B. Studs and Runners: ASTM C 645.

1. Steel Studs and Runners:

a. Minimum Base-Metal Thickness: As indicated on Drawings.

b. Depth: As indicated on Drawings.

C. Slip-Type Head Joints: Where indicated, provide one of the following:

1. Single Long-Leg Runner System: ASTM C 645 top runner with 2-inch-(51-mm-) deep flanges in thickness not less than indicated for studs, installed with studs friction fit into top runner and with continuous bridging located within 12 inches (305 mm) of the top of studs to provide lateral bracing.

2. Deflection Track: Steel sheet top runner manufactured to prevent cracking of finishes applied to interior partition framing resulting from deflection of structure above; in thickness not less than indicated for studs and in width to accommodate depth of studs.

   a. Products: Subject to compliance with requirements, provide one of the following:

      1) ClarkDietrich Building Systems; SLP-TRK Slotted Deflection Track.
      2) Steel Network Inc; VertiTrack VTD.

D. Flat Strap and Backing Plate: Steel sheet for blocking and bracing in length and width indicated.

   1. Minimum Base-Metal Thickness: 0.018 inch (0.45 mm).

E. Cold-Rolled Channel Bridging: Steel, 0.053-inch (1.34-mm) minimum base-metal thickness, with minimum 1/2-inch-(13-mm-)wide flanges.

   1. Depth: 1-1/2 inches (38 mm).

   2. Clip Angle: Not less than 1-1/2 by 1-1/2 inches (38 by 38 mm), 0.068-inch-(1.72-mm-)thick, galvanized steel.

F. Hat-Shaped, Rigid Furring Channels: ASTM C 645.

   1. Minimum Base-Metal Thickness: 0.018 inch (0.45 mm).

   2. Depth: 7/8 inch (22.2 mm) unless otherwise noted.

G. Resilient Furring Channels: 1/2-inch-(13-mm-) deep, steel sheet members designed to reduce sound transmission.

   1. Configuration: Asymmetrical.

H. Cold-Rolled Furring Channels: 0.053-inch (1.34-mm) uncoated-steel thickness, with minimum 1/2-inch-(13-mm-) wide flanges.

   1. Depth: 3/4 inch (19 mm).

   2. Furring Brackets: Adjustable, corrugated-edge type of steel sheet with minimum uncoated-steel thickness of 0.033 inch (0.8 mm).

   3. Tie Wire: ASTM A 641/A 641M, Class 1 zinc coating, soft temper, 0.062-inch-(1.59-mm-)diameter wire, or double strand of 0.048-inch-(1.21-mm-)diameter wire.

I. Z-Shaped Furring: With slotted or nonslotted web, face flange of 1-1/4 inches (32 mm), wall attachment flange of 7/8 inch (22 mm), minimum uncoated-metal thickness of 0.018 inch (0.45 mm), and depth required to fit insulation thickness indicated.

2.3 AUXILIARY MATERIALS

A. General: Provide auxiliary materials that comply with referenced installation standards.

1. Fasteners for Metal Framing: Of type, material, size, corrosion resistance, holding power, and other properties required to fasten steel members to substrates.

B. Isolation Strip at Exterior Walls: Provide the following:

1. Foam Gasket: Adhesive-backed, closed-cell vinyl foam strips that allow fastener penetration without foam displacement, 1/8 inch (3.2 mm) thick, in width to suit steel stud size.

PART 3 EXECUTION

3.1 EXAMINATION

A. Examine areas and substrates, with Installer present, and including welded hollow-metal frames, cast-in anchors, and structural framing, for compliance with requirements and other conditions affecting performance of the Work.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

A. Suspended Assemblies: Coordinate installation of suspension systems with installation of overhead structure to ensure that inserts and other provisions for anchorages to building structure have been installed to receive hangers at spacing required to support the Work and that hangers will develop their full strength.

1. Furnish concrete inserts and other devices indicated to other trades for installation in advance of time needed for coordination and construction.

3.3 INSTALLATION, GENERAL

A. Installation Standard: ASTM C 754.

1. Gypsum Board Assemblies: Comply with requirements in ASTM C 840 that apply to framing installation.

B. Install supplementary framing, and blocking to support fixtures, equipment services, heavy trim, grab bars, toilet accessories, furnishings, or similar construction.

C. Install bracing at terminations in assemblies.

D. Do not bridge building control and expansion joints with non-load-bearing steel framing members. Frame both sides of joints independently.

3.4 INSTALLING FRAMED ASSEMBLIES

A. Z-Shaped Furring Members:

1. Erect insulation, specified in Section 07210 "Thermal Insulation," vertically and hold in place with Z-shaped furring members spaced 24 inches (610 mm)o.c.

2. Except at exterior corners, securely attach narrow flanges of furring members to wall with concrete stub nails, screws designed for masonry attachment, or powder-driven fasteners spaced 24 inches (610 mm) o.c.

3. At exterior corners, attach wide flange of furring members to wall with short flange extending beyond corner; on adjacent wall surface, screw-attach short flange of furring channel to web of attached channel. At interior corners, space second member no more than 12 inches (305 mm) from corner and cut insulation to fit.

B. Where studs are installed directly against exterior masonry walls or dissimilar metals at exterior walls, install isolation strip between studs and exterior wall.

C. Install studs so flanges within framing system point in same direction.

D. Install tracks (runners) at floors and overhead supports. Extend framing full height to structural supports or substrates above suspended ceilings except where partitions are indicated to terminate at suspended ceilings. Continue framing around ducts penetrating partitions above ceiling.

1. Slip-Type Head Joints: Where framing extends to overhead structural supports, install to produce joints at tops of framing systems that prevent axial loading of finished assemblies.

2. Door Openings: Screw vertical studs at jambs to jamb anchor clips on door frames; install runner track section (for cripple studs) at head and secure to jamb studs.

3. Install two studs at each jamb unless otherwise indicated.

4. Other Framed Openings: Frame openings other than door openings the same as required for door openings unless otherwise indicated. Install framing below sills of openings to match framing required above door heads.

5. Fire-Resistance-Rated Partitions: Install framing to comply with fire-resistance-rated assembly indicated and support closures and to make partitions continuous from floor to underside of solid structure.

E. Direct Furring:

1. Attach to concrete or masonry with stub nails, screws designed for masonry attachment, or powder-driven fasteners spaced 24 inches (610 mm) o.c.

F. Installation Tolerance: Install each framing member so fastening surfaces vary not more than 1/8 inch (3 mm) from the plane formed by faces of adjacent framing.

END OF SECTION

SECTION 09250 - GYPSUM BOARD

PART 1 GENERAL

1.1 SUMMARY

A. Section Includes:

1. Fiber Reinforced Interior gypsum board.

1.2 SUBMITTALS

A. Product Data: For each type of product.

1. For adhesives used to laminate gypsum board panels to substrates, documentation including printed statement of VOC content.

B. Samples: For the following products:

1. Trim Accessories: Full-size Sample in 12-inch- (300-mm-) long length for each trim accessory indicated.

1.3 QUALITY ASSURANCE

A. Mockups: Before beginning gypsum board installation, install mockups of at least 4 feet wide by full height of wall, to demonstrate aesthetic effects and set quality standards for materials and execution.

1. Apply or install final decoration indicated, including painting and wallcoverings, on exposed surfaces for review of mockups.

2. Simulate finished lighting conditions for review of mockups.

3. Subject to compliance with requirements, approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.

1.4 DELIVERY, STORAGE AND HANDLING

A. Store materials inside under cover and keep them dry and protected against weather, condensation, direct sunlight, construction traffic, and other potential causes of damage. Stack panels flat and supported on risers on a flat platform to prevent sagging.

1.5 FIELD CONDITIONS

A. Environmental Limitations: Comply with ASTM C 840 requirements or gypsum board manufacturer's written recommendations, whichever are more stringent.

B. Do not install paper-faced gypsum panels until installation areas are enclosed and conditioned.

C. Do not install panels that are wet, those that are moisture damaged, and those that are mold damaged.

1. Indications that panels are wet or moisture damaged include, but are not limited to, discoloration, sagging, or irregular shape.

2. Indications that panels are mold damaged include, but are not limited to, fuzzy or splotchy surface contamination and discoloration.

PART 2 PRODUCTS

2.1 GYPSUM BOARD, GENERAL

A. Size: Provide maximum lengths and widths available that will minimize joints in each area and that correspond with support system indicated.

2.2 FIBER REINFORCED INTERIOR GYPSUM BOARD

A. Product: USG Corporation “Fiberock” Abuse Resistant Panels, or equal by one of the following:

1. American Gypsum.

2. CertainTeed Corp.

3. Georgia-Pacific Gypsum LLC.

4. National Gypsum Company.

B. Gypsum Wallboard: ASTM C 1278.

1. Basis of Design:

a. Abrasion Resistance; Level 1.
b. Indentation Resistance; Level 1.
c. Soft Body Impact Resistance; Level 2.
d. Hard Body Impact Resistance; Level 1.

2. Thickness: 5/8 inch (15.9 mm).

3. Long Edges: Tapered.

4. UL Type Designation “FRX-G”.

5. ASTM E84 Surface-Burning Characteristics:

a. Flame Spread: 5.
b. Smoke Developed: 0.

2.3 TRIM ACCESSORIES

A. Interior Trim: ASTM C 1047.

1. Material: Galvanized or aluminum-coated steel sheet or rolled zinc or paper-faced galvanized steel sheet.

2. Shapes:

a. Cornerbead.
b. LC-Bead: J-shaped; exposed long flange receives joint compound.
c. Expansion (control) joint.

B. Aluminum Trim: Extruded accessories of profiles and dimensions indicated.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. Fry Reglet Corp.
b. Gordon, Inc.
c. Pittcon Industries.

2. Aluminum: Alloy and temper with not less than the strength and durability properties of ASTM B 221 (ASTM B 221M), Alloy 6063-T5.

3. Finish: Corrosion-resistant primer compatible with joint compound and finish materials specified.

2.4 JOINT TREATMENT MATERIALS

A. General: Comply with ASTM C 475/C 475M.

B. Joint Tape:

1. Interior Gypsum Board: Paper for abuse resistant assemblies.

C. Joint Compound for Interior Gypsum Board: For each coat use formulation that is compatible with other compounds applied on previous or for successive coats.

1. Prefilling: At open joints, rounded or beveled panel edges, and damaged surface areas, use setting-type taping compound.

2. Embedding and First Coat: For embedding tape and first coat on joints, fasteners, and trim flanges, use setting-type taping compound.

a. Use setting-type compound for installing paper-faced metal trim accessories.

3. Fill Coat: For second coat, use setting-type, sandable topping compound.

4. Finish Coat: For third coat, use drying-type, all-purpose compound.

2.5 AUXILIARY MATERIALS

A. General: Provide auxiliary materials that comply with referenced installation standards and manufacturer's written recommendations.

B. Steel Drill Screws: ASTM C 1002, unless otherwise indicated.

1. Use screws complying with ASTM C 954 for fastening panels to steel members from 0.033 to 0.112 inch (0.84 to 2.84 mm) thick.

PART 3 EXECUTION

3.1 EXAMINATION

A. Examine areas and substrates including welded hollow-metal frames and framing, with Installer present, for compliance with requirements and other conditions affecting performance.

B. Examine panels before installation. Reject panels that are wet, moisture damaged, and mold damaged.

C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 APPLYING AND FINISHING PANELS, GENERAL

A. Comply with ASTM C 840.

B. Install panels with face side out. Butt panels together for a light contact at edges and ends with not more than 1/16 inch (1.5 mm) of open space between panels. Do not force into place.

C. Locate edge and end joints over supports, except in ceiling applications where intermediate supports or gypsum board back-blocking is provided behind end joints. Do not place tapered edges against cut edges or ends. Stagger vertical joints on opposite sides of partitions. Do not make joints other than control joints at corners of framed openings.

D. Form control and expansion joints with space between edges of adjoining gypsum panels.

E. Cover both faces of support framing with gypsum panels in concealed spaces (above ceilings, etc.), except in chases braced internally.

1. Unless concealed application is indicated or required for sound, fire, air, or smoke ratings, coverage may be accomplished with scraps of not less than 8 sq. ft. (0.7 sq. m) in area.

2. Fit gypsum panels around ducts, pipes, and conduits.

3. Where partitions intersect structural members projecting below underside of floor/roof framing and decks, cut gypsum panels to fit profile formed by structural members; allow 1/4- to 3/8-inch- (6.4- to 9.5-mm-) wide joints to install sealant.

F. Isolate perimeter of gypsum board applied to non-load-bearing partitions at structural abutments, except floors. Provide 1/4- to 1/2-inch- (6.4- to 12.7-mm-) wide spaces at these locations and trim edges with edge trim where edges of panels are exposed. Seal joints between edges and abutting structural surfaces with acoustical sealant.

G. Attachment to Steel Framing: Attach panels so leading edge or end of each panel is attached to open (unsupported) edges of stud flanges first.

3.3 APPLYING INTERIOR GYPSUM BOARD

A. Install interior gypsum board in the following locations:

1. Wallboard Type: Vertical surfaces unless otherwise indicated.

B. Single-Layer Application:

1. On partitions/walls, apply gypsum panels vertically (parallel to framing) unless otherwise indicated or required by fire-resistance-rated assembly, and minimize end joints.

a. Stagger abutting end joints not less than one framing member in alternate courses of panels.
b. At stairwells and other high walls, install panels horizontally unless otherwise indicated or required by fire-resistance-rated assembly.

2. Fastening Methods: Apply gypsum panels to supports with steel drill screws.

3.4 INSTALLING TRIM ACCESSORIES

A. General: For trim with back flanges intended for fasteners, attach to framing with same fasteners used for panels. Otherwise, attach trim according to manufacturer's written instructions.

B. Control Joints: Install control joints according to ASTM C 840 and according to manufacturer’s written instructions.

C. Interior Trim: Install in the following locations:

1. Cornerbead: Use at outside corners unless otherwise indicated.

2. LC-Bead: Use at exposed panel edges.

D. Aluminum Trim: Install in locations indicated on Drawings.

3.5 FINISHING GYPSUM BOARD

A. General: Treat gypsum board joints, interior angles, edge trim, control joints, penetrations, fastener heads, surface defects, and elsewhere as required to prepare gypsum board surfaces for decoration. Promptly remove residual joint compound from adjacent surfaces.

B. Prefill open joints, rounded or beveled edges, and damaged surface areas.

C. Apply joint tape over gypsum board joints, except for trim products specifically indicated as not intended to receive tape.

D. Gypsum Board Finish Levels: Finish panels to levels indicated below and according to ASTM C 840:

1. Level 4: At panel surfaces that will be exposed to view unless otherwise indicated.

a. Primer and its application to surfaces are specified in Section 09990 Painting and Coatings.

3.6 PROTECTION

A. Protect adjacent surfaces from drywall compound and promptly remove from floors and other non-drywall surfaces. Repair surfaces stained, marred, or otherwise damaged during drywall application.

B. Protect installed products from damage from weather, condensation, direct sunlight, construction, and other causes during remainder of the construction period.

C. Remove and replace panels that are wet, moisture damaged, and mold damaged.

1. Indications that panels are wet or moisture damaged include, but are not limited to, discoloration, sagging, or irregular shape.

2. Indications that panels are mold damaged include, but are not limited to, fuzzy or splotchy surface contamination and discoloration.

END OF SECTION

SECTION 09900 – PAINTING AND COATINGS

PART 1 GENERAL

1.1 THE REQUIREMENT

A. The Contractor shall provide protective coatings, complete and in place, in accordance with the Contract Documents.

B. Definitions

1. The term "paint," "coatings," or "finishes" as used herein, shall include surface treatments, emulsions, enamels, paints, epoxy resins, and all other protective coatings, excepting galvanizing or anodizing, whether used as a pretreatment, primer, intermediate coat, or finish coat.

2. The term "DFT" means minimum dry film thickness.

C. The following surfaces shall not be protective coated hereunder unless indicated.

1. Concrete

2. Concrete block

3. Stainless steel

4. Machined surfaces

5. Grease fittings

6. Glass

7. Equipment nameplates

8. Platform gratings, stair treads, door thresholds and other walk surfaces

D. The coating system schedules summarize the surfaces to be coated, the required surface preparation, and the coating systems to be applied. Coating notes on the drawings are used to show exceptions to the schedules, to show or extend the limits of coating systems, or to clarify or show details for application of the coating systems.

E. Where protective coatings are to be performed by a subcontractor, the subcontractor shall possess a valid state license as required for performance of the painting and coating work called for in this specification and] shall provide 5 references which show that the painting subcontractor has previous successful experience with the indicated or comparable coating systems. Include the name, address, and the telephone number for the owner of each installation for which the painting subcontractor provided the protective coating.

1.2 REFERENCE SPECIFICATIONS, CODES AND STANDARDS

1.3 CONTRACTOR SUBMITTALS

A. General: Submittals shall be furnished in accordance with Section 01340, Submittals, unless indicated otherwise below.

B. Submittals shall include the following information and be submitted at least 30 days prior to protective coating work:

1. Coating Materials List: Eight copies of a coating materials list showing the Manufacturer and the coating number, keyed to the coating systems herein. The list shall be submitted prior to or at the time of submittal of samples.

2. Paint Manufacturer's Information: For each coating system to be used, the following data:

    a. Paint Manufacturer's data sheet for each product proposed, including statements on the suitability of the material for the intended use.
    b. Technical and performance information that demonstrates compliance with the system performance and material requirements.
    c. Paint Manufacturer's instructions and recommendations on surface preparation and application.
    d. Colors available for each product (where applicable).
    e. Compatibility of shop and field applied coatings (where applicable).
    f. Material Safety Data Sheet for each product used.

3. Submit Notarized Certificate that:
    a. All paints and coatings to be used on this project shall comply with current VOC regulations of the State of California Air Management District in which the coatings will be used.

4. Manufacturer Certification:
    a. Submit Manufacturer certification that Applicator has been trained and approved in the handling, mixing and application of the products to be used.
    b. Submit certification that the equipment to be used for applying the products has been manufactured or approved by the epoxy coating manufacturer and Applicator personnel have been trained and certified for proper use of the equipment.

C. Samples

1. Samples of all paint, finishes, and other coating materials shall be submitted on 8-1/2-inch by 11-inch sheet metal. Each sheet shall be completely coated over its entire surface with one protective coating material, type, and color.

2. Two sets of color samples to match each color selected by the Engineer from the Manufacturer's standard color sheets. If custom mixed colors are indicated, the color samples shall be made using color formulations prepared to match the color samples furnished by the Engineer. The color formula shall be shown on the back of each color sample.

3. One fifteen pound sample of each abrasive proposed to be used for surface preparation for submerged and severe service coating systems.

1.4 SPECIAL CORRECTION OF DEFECTS REQUIREMENTS

A. Warranty Inspection: A warranty inspection may be conducted during the eleventh month following completion of all coating and painting work. The Contractor and a

representative of the coating material Manufacturer shall attend this inspection. All defective work shall be repaired in accordance with these specifications and to the satisfaction of the Owner. The Owner may, by written notice to the Contractor, reschedule the warranty inspection to another date within the one-year correction period, or may cancel the warranty inspection altogether. If a warranty inspection is not held, the Contractor is not relieved of its responsibilities under the Contract Documents.

B. System 104 – Epoxy All Liner shall have an extended 5 year warranty for all installation and material defects.

PART 2 PRODUCTS

2.1 GENERAL

A. Suitability: The Contractor shall use suitable coating materials as recommended by the Manufacturer.

B. Compatibility: In any coating system only compatible materials from a single Manufacturer shall be used in the work. Particular attention shall be directed to compatibility of primers and finish coats. If necessary, a barrier coat shall be applied between existing prime coat and subsequent field coats to ensure compatibility.

C. Containers: Coating materials shall be sealed in containers that plainly show the designated name, formula or specification number, batch number, color, date of manufacture, and name of manufacturer, all of which shall be plainly legible at the time of use.

D. Colors: All colors and shades of colors of all coats of paint shall be as indicated or selected by the Engineer. Each coat shall be of a slightly different shade, to facilitate inspection of surface coverage of each coat. Finish colors shall be as selected from the manufacturer's standard color samples by the Engineer.

E. Substitute or "Or-Equal" Products

1. To establish equality, the Contractor shall furnish satisfactory documentation from the manufacturer of the proposed substitute or or-equal product that the material meets the indicated requirements and is equivalent or better in the following properties:

    a. Quality
    b. Durability
    c. Resistance to abrasion and physical damage
    d. Life expectancy
    e. Ability to recoat in future
    f. Solids content by volume
    g. Dry film thickness per coat
    h. Compatibility with other coatings
    i. Suitability for the intended service
    j. Resistance to chemical attack
    k. Temperature limitations in service and during application
    l. Type and quality of recommended undercoats and topcoats
    m. Ease of application
    n. Ease of repairing damaged areas
    o. Stability of colors

2. Protective Coating Materials shall be standard products produced by recognized manufacturers who are regularly engaged in production of such materials for essentially identical service conditions. Where requested, the Contractor shall provide the Engineer with the names of not less than 10 successful applications of the proposed manufacturer's products which comply with these requirements.

3. The cost of all testing and analyzing proposed substitute products which may be required by the Engineer shall be paid by the Contractor at no additional cost to the Owner. If a proposed substitution requires changes in the Work, the Contractor shall bear all such costs involved and the costs of allied trades affected by the substitution at no additional cost to the Owner.

2.2 INDUSTRIAL COATING SYSTEMS

A. Material Sources: Each of the following manufacturers is capable of supplying many of the industrial coating materials indicated herein. Where manufacturers and paint numbers are listed, it is to show the type and quality of coatings that are required. Proposed substitute materials will be considered as indicated above. All industrial coating materials shall be materials that have a record of satisfactory performance in industrial plants, manufacturing facilities, and water and wastewater treatment plants.

1. Ameron

2. Sherwin Williams

3. Carboline Coatings Company

4. ICI - Devoe Coatings Company

5. Glidden Coatings and Resins

6. Inorganic Coatings, Inc

7. International Protective Coatings – Porter

8. Tnemec Company

9. Valspar Corporation

B. System 1 - Alkyd Enamel: High quality, gloss or semi-gloss, medium long oil alkyd finish shall have a minimum solids content of 49 percent by volume. Primer shall be as recommended by manufacturer.

1. Prime coat DFT = 3 mils Ameron 5105, Tnemec V115 Uni-Bond, or equal.

2. Finish coats (two or more, DFT = 3 mils), Ameron 5401 HS, Tnemec 1029 Enduratone, or equal.

3. Total system DFT = 6 mils.

C. System 2 – Not used.

D. System 3 – Aluminum Silicone Resin: Aluminum silicone resin material shall be suitable for a service temperature of up to 1,000 degrees F, and shall comply with Federal Specification TT-P-28 - Paint, Aluminum, Heat Resisting (1200 degrees F)

1. Prime coat and finish coat (2 or more, DFT = 3 mils), Tnemec Series 39-1061, Ameron 878, or equal.

2. Total system DFT = 3 mils.

E. System 4 - Aliphatic Polyurethane: Two component aliphatic acrylic polyurethane coating material shall provide superior color and gloss retention, resistance to splash from acid and alkaline chemicals, resistance to chemical fumes and severe weathering and with a minimum solids content of 58 percent by volume. Primer shall be a rust inhibitive two component epoxy coating with a minimum solids content of 68 percent by volume.

1. Prime coat DFT = 4 mils, Amerlock 2/400, Carboline Carboguard 890, Tnemec L69 Epoxoline or equal.

2. Finish coat (one or more, DFT = 3 mils), Ameron Amershield VOC, Carbothane 134 MC, Tnemec Endura-Shield Series 1095, or equal.

3. Total system DFT = 7 mils.

4. More than one finish coat shall be applied as necessary to produce a finish with uniform color and texture.

F. System 6 – Inorganic Zinc, Water Based: Water based, self curing, zinc silicate coating material shall be a two component inorganic coating material that contains at least 85 percent of metallic zinc by weight in the dried film.

1. Prime coat and finish coat (One, DFT = 3 mils), Ameron Dimetcote 21-5, Inorganic Coatings 531, Valspar 13-F-6, or equal.

2. Total system DFT = 3 mils.

G. System 7 - Acrylic Latex: Single component, water based acrylic latex with a fungicide additive shall have a minimum solids content of 35 percent by volume. Prime coat shall be as recommended by manufacturer. The coating material shall be available in the ANSI safety colors.

1. Prime coat DFT = 2 mils, as recommended by manufacturer.

2. Finish coats (2 or more, DFT = 6 mils), Amercoat 220, Carboline 3359, 1026 Enduratone, or equal.

3. Total system DFT = 8 mils.

H. System 8 - Epoxy, Equipment: Two component, rust inhibitive polyamide cured epoxy coating material shall provide a recoatable finish that is available in a wide selection of colors. The coating material shall have a minimum solids content of 66 percent by volume and be resistant to service conditions of condensing moisture, splash and spillage of lubricating oils, and frequent washdown and cleaning.

1. Prime coat DFT = 3 mils, Ameron 385, Tnemec L69 Epoxoline, or equal

2. Prime coat, where shop applied. (DFT = 3 mils), universal primer, Ameron 185 HS, Tnemec L69 Epoxoline, or equal**..**

3. Finish coats (2 or more, DFT = 6 mils), Amerlock 385, Tnemec L69 Epoxoline, or equal.

4. Total system DFT = 9 mils.

I. System 10 - Acrylic, Concrete: The acrylic coating material shall be a single component, industrial grade, high molecular weight, waterborne acrylic material with a solids content of at least 35 percent by volume. The filler-sealer shall be a two component epoxy masonry sealer for wet and exterior exposure, with a solids content of at least 64 percent by volume. A 100 percent solids epoxy surfacer shall be used to fill holes and patch the concrete surface after abrasive blasting.

1. Prime coat (filler-sealer), applied in two coats to the entire surface and worked into the surface with a squeegee to achieve a smooth, void-free surface, Tnemec 130 Envirofill, Ameron Nu-Klad 105A followed by Nu-Klad 114A (2 coats) or equal.

2. Finish coats (2 or more, DFT = 6 mils), Tnemec 1026 Enduratone, Ameron 220, or equal.

J. System 11 - Aliphatic Polyurethane, Concrete: Two component aliphatic polyurethane coating material shall provide superior color and gloss retention, resistance to splash from acid and alkaline chemicals, resistance to chemical fumes and severe weathering, and contain a minimum solids content of 65 percent by volume. Filler-sealer compound shall be a two component epoxy material used to provide a smooth surface for the epoxy intermediate coat. The filler-sealer is applied to the entire concrete surface and worked into the concrete surface with a wide blade putty knife or squeegee. The intermediate coat shall be a high-build epoxy coating with a minimum solids content of 70 percent by volume.

1. Prime coat (Filler-sealer), Ameron Nu-Klad 105A followed by Nu-Klad 114, Tnemec 130 Envirofill, or equal.

2. Intermediate coat DFT = 4 mils, Ameron 400, Tnemec L69 Epoxoline or equal.

3. Finish coats (2 or more, DFT = 3 mils), Ameron Amershield, Tnemec 1095 Endura-Shield, or equal.

2.3 SUBMERGED AND SEVERE SERVICE COATING SYSTEMS

A. Materials Sources: The manufacturers' products listed in this paragraph are materials which satisfy the material descriptions of this paragraph and have a documented successful record for long term submerged or severe service conditions. Proposed substitute products will be considered as indicated above.

B. System 100 - Amine Cured Epoxy: High build, amine cured, epoxy resin shall have a solids content of at least 80 percent by volume, and shall be suitable for long-term immersion service in potable water and municipal wastewater. For potable water service, the coating material shall be listed by the NSF International as in compliance with NSF Standard 61 - Drinking Water System Components - Health Effects.

1. Prime coat and finish coats (3 or more, DFT = 16 mils), Ameron 400, Tnemec L140F Pota-Pox, Carboguard 890, Sherwin Williams Tank Clad HS or equal

2. For coating of valves and non-submerged equipment, DFT = 12 mils.

C. System 101 - Cold-Applied Tape: Tape coating materials and procedures shall be in accordance with ANSI/AWWA C209. Prefabricated tape shall be Type II. The system shall consist of a primer layer, inner layer tape (35 mils), and an outer layer tape (35 mils). Total system DFT = 70 mils.

D. System 102 - Polyamide Cured Epoxy: High build, polyamide epoxy resin shall have a solids content of at least 56 percent by volume, and shall be suitable for long-term immersion in potable water and municipal wastewater. For potable water service, the coating material shall be listed by the NSF International as in compliance with NSF Standard 61.

1. Prime coat and finish coats (3 or more, DFT = 12 mils), Tnemec L140F Pota-Pox, Sherwin William Macropoxy 646, or equal.

E. System 104 - Epoxy Wall Liner: Ultra High build, epoxy resin shall be 100% solids content, and shall be suitable for long-term immersion service in municipal wastewater, and on buried dry inside concrete walls with high groundwater on the outside.

1. Filler and Surfacer, Tnemec 218 Mortarclad, Finish coat. Tnemec 435 Perma-Glaze (2 or more, DFT = 60-80 mils), Raven Lining Systems, or equal.

F. System 106 - Fusion Bonded Epoxy: The coating material shall be a 100 percent powder epoxy applied in accordance with the ANSI/AWWA C213 - Fusion-Bonded Epoxy Coating for the Interior and Exterior of Steel Water Pipelines, except that the surface preparation shall be as specified in the coating system schedule of this Section. The coating shall be applied using the fluidized bed process.

1. Liquid Epoxy: For field repairs, the use of a liquid epoxy will be permitted, applied in not less than 3 coats to provide a DFT of 15 mils. The liquid epoxy shall be a 100 percent solids epoxy recommended by the powder epoxy manufacturer.

2. Coating DFT = 16 mils, Scotchkote 134 or 206N, or equal.

3. Total system DFT = 16 mils.

4. For coating of valves, DFT - 12 mils.

G. System 107 – Chemical Resistant Sheet Lining:

1. Materials: The CONTRACTOR shall use natural rubber, chlorobutyl rubber, ethylene propylene diene monomer (EPDM) rubber, chloroprene polymer (neoprene) rubber, or chlorosulfonated polyethylene (Hypalon) rubber sheet lining materials as indicated. The shop drawing submittal shall contain technical information that confirms the suitability of the lining material system for long-term immersion in each chemical to be stored. The service temperatures are expected to be up to 150 degrees F.

2. Neoprene sheet lining material shall be synthetic rubber formulated for steam curing at atmospheric pressure. The minimum lining thickness shall be 3/16 - inch. The lining material shall be B.F. Goodrich compound 59688, or equal.

3. Chlorobutyl sheet lining material shall be synthetic rubber formulated for steam curing at atmospheric pressure. The minimum lining thickness shall be 3/16-inch. The lining material shall be B.F. Goodrich compound 60924, or equal.

4. Natural rubber (soft) sheet lining material shall be soft natural rubber formulated for steam curing at atmospheric pressure. The minimum lining thickness shall be 3/16-inch. The lining material shall be B.F. Goodrich compound 83160, or equal.

5. Natural rubber (hard) sheet lining material shall be a hard, natural rubber resistant to oxidizing agents and formulated for autoclave curing. The minimum lining thickness shall be 3/16 inch. The lining material shall be B.F. Goodrich compound 8631, or equal.

6. EPDM sheet lining material shall be synthetic rubber suitable for use as a lining for 50 percent sulfuric acid solution and formulated for autoclave or steam curing under pressure.

7. Hypalon sheet lining material shall be synthetic rubber suitable for use as a lining for 50 percent sulfuric acid solution.

8. Primers, adhesives, activators, accelerators and other necessary materials shall be as required by the sheet material manufacturer.

9. Metal Surface Preparation: Prior to abrasive blast cleaning the base metal shall be prepared as required by the sheet lining material manufacturer's installation instructions. If the instructions differ from these specifications the highest degree of cleaning and surface preparation shall be provided. Abrasive blast cleaning shall be done in accordance with this Section.

10. Installation of lining materials shall be in accordance with the material manufacturer's written installation instructions. All interior surfaces shall be lined, including all piping, vents, fittings, flange faces, manhole covers, and blind flanges.

11. The lining system shall be holiday tested in accordance with this Section before and after curing.

12. The lining system shall be cured by steam using the time and temperature as required by the material manufacturer.

2.4 SPECIAL COATING SYSTEMS

A. System 200 - PVC Tape: Prior to wrapping the pipe with PVC tape, the pipe and fittings first shall be primed using a primer recommended by the PVC tape manufacturer. After being primed, the pipe shall be wrapped with a 20-mil adhesive PVC tape, half-lapped, to a total thickness of 40 mils.

B. System 201 - Rich Portland Cement Mortar: Rich portland cement mortar coating shall have a minimum thickness of 1/8-inch, followed by enclosure in an 8-mil thick polyethylene sheet with all joints and edges lapped and sealed with tape.

C. System 203 - Epoxy Surfacing: Two-component epoxy floor surfacing shall be formulated to resist many acids, alkalies, and solvents. Material shall be resistant to liquid alum, sodium hydroxide, and 50 percent sulfuric acid. Prior to epoxy surfacing, prepare surface with void filler. Products shall be as follows, or equal:

1. Void Filler: Tnemec 215 Surfacing Epoxy. Nu-Klad 100A, or equal as needed.

2. Epoxy Surfacing: Tnemec 239 Chemtread, Finish Coat, 282 Tneme-Glaze. Prime coat Nu-Klad 105; finish coat Nu-Klad 110 (1/4-inch thick), or equal.

D. System 204 - Water-Retardant: Two coats of a clear, non-staining, silane-modified-siloxane masonry water-retardant material. The water-retardant system after application shall be provided with not less than a five-year warranty on the performance of the product.

1. Chemstop "Barricade;" Rainguard "Blok-Lok"; Rainproof "Chem-Trete #45"; Tnemec 633 Prime-A-Pell H20 or equal.

2. Surfaces shall be cleaned with a chemical cleaner approved by the manufacturer and power wash. Surfaces shall be clean and dry before application of the material. Method and rate of application shall be in accordance with manufacturer's published instructions. A manufacturer's representative shall be present during applications if necessary for warranty.

E. System 205 - Polyethylene Encasement: Application of polyethylene encasement shall be in accordance with ANSI/AWWA C105 using Method C.

F. System 206 - Cement Mortar Coating: A 1-1/2-inch minimum thickness mortar coating reinforced with 3/4-inch galvanized welded wire fabric shall be provided. The cement mortar shall contain no less than one part Type V cement to 3 parts sand. The cement mortar shall be cured by a curing compound meeting the reqirements of "Liquid Membrane Forming Compounds for Curing Concrete," ASTM C 309, Type II, white pigmented, or by enclosure in an 8-mil thick polyethylene sheet with all edges and joints lapped by at least 6 inches.

G. System 208 - Aluminum Metal Isolation: Two coats of a high build polyamide epoxy paint, such as Tnemec L69 Epoxoline, or equal (8 mils). Total thickness of system DFT = 8.0 mils.

H. System 209 - Alkyd or Acrylic-Wood: Industrial quality, gloss or semi-gloss, with a minimum solids content of 40 percent by volume. Primer shall be as recommended by the manufacturer.

1. Prime coat DFT = 3 mils.

2. Finish coats (two or more, DFT = 3 mils), Amercoat 5401, Tnemec 1029 Enduratone, or equal.

3. Total system DFT = 6 mils.

I. System 210 - Acrylic-wood: Single component, water-based acrylic latex coating material with a fungicide additive and a minimum solids content of 35 percent by volume. Primer shall be an alkyd primer as recommended by the manufacturer.

1. Prime coat DFT = 2 mils.

2. Finish coats (two or more, DFT = 6 mils), Amerguard 220, Carboline 3300, Tnemec 1026 Enduratone, or equal.

3. Total system DFT = 8 mils.

J. System 211 - Acrylic-Drywall: Single component, water-based acrylic latex coating material with a fungicide additive and a minimum solids content of 35 percent by volume. Primer shall be a PVA sealer as recommended by the manufacturer.

1. Prime coat DFT = 1.5 mils

2. Finish coats (two or more, DFT = 6 mils), Amerguard 220, Carboline 3300, Tnemec 1026 Enduratone, or equal.

3. Total system DFT = 7.5 mils.

K. System 212 - Existing and patched exterior stucco over CMU or concrete: water-based elastomeric coating. Primer to be acrylic primer for existing stucco.

1. Material Source; Sherwin Williams, Carboline, ICI Devoe

2. Prime coat DFT = 3.2 mils, Loxon Acrylic Primer A24W300, Carboline Flexxide, ICI 3030 Bond Prep or equal.

3. Finish coats (two or more, DFT = 4-6 mils), SherLastic Elastomeric Coating A5-100, Carboline Flexxide, ICI Decraflex 2260 Elastomeric Smooth or equal.

PART 3 EXECUTION

3.1 MANUFACTURER'S SERVICES

A. The Contractor shall require the protective coating manufacturer to furnish a qualified technical representative to visit the project site for technical support as may be necessary to resolve field problems attributable or associated with the manufacturer's products.

3.2 WORKMANSHIP

A. Skilled craftsmen and experienced supervision shall be used on all Work.

B. Coating shall be done in a workmanlike manner so as to produce an even film of uniform thickness. Edges, corners, crevices, and joints shall receive special attention to insure thorough cleaning and an adequate thickness of coating material. The finished surfaces shall be free from runs, drops, ridges, waves, laps, brush marks, and variations in color, texture, and finish. The hiding shall be so complete that the addition of another coat would not increase the hiding. Special attention shall be given to insure that edges, corners, crevices, welds, and similar areas receive a film thickness equivalent to adjacent areas, and installations shall be protected by the use of drop cloths or other precautionary measures.

C. All damage to surfaces resulting from the Work shall be cleaned, repaired, and refinished to original condition.

3.2 STORAGE MIXING AND THINNING OF MATERIALS

A. Manufacturer's Recommendations: Unless otherwise indicated, the coating manufacturer's printed recommendations and instructions for thinning, mixing, handling, applying, and protecting its coating materials, for preparation of surfaces for coating, and for all other procedures relative to coating shall be strictly observed.

B. All protective coating materials shall be used within the manufacturer's recommended shelf life.

C. Storage and Mixing: Coating materials shall be stored under the conditions recommended by the Material Safety Data Sheets, and shall be thoroughly stirred, strained, and kept at a uniform consistency during application. Coatings of different manufacturers shall not be mixed together.

3.3 PREPARATION FOR COATING

A. General: All surfaces to receive protective coatings shall be cleaned as indicated prior to application of coatings. The Contractor shall examine all surfaces to be coated, and shall correct all surface defects before application of any coating material. All marred or abraded spots on shop-primed and on factory-finished surfaces shall receive touch-up restoration prior to any coating application. Surfaces to be coated shall be dry and free of visible dust.

B. Protection of Surfaces Not to be Coated: Surfaces which are not to receive protective coatings shall be protected during surface preparation, cleaning, and coating operations.

C. All hardware, lighting fixtures, switchplates, machined surfaces, couplings, shafts, bearings, nameplates on machinery, and other surfaces not to be painted shall be removed, masked or otherwise protected. Drop cloths shall be provided to prevent coating materials from falling on or marring adjacent surfaces. The working parts of all mechanical and electrical equipment shall be protected from damage during surface preparation and coating operations. Openings in motors shall be masked to prevent entry of coating or other materials.

D. Care shall be exercised not to damage adjacent work during blast cleaning operations. Spray painting shall be conducted under carefully controlled conditions. The Contractor shall be fully responsible for and shall promptly repair any and all damage to adjacent work or adjoining property occurring from blast cleaning or coating operations.

E. Protection of Painted Surfaces: Cleaning and coating shall be coordinated so that dust and other contaminants from the cleaning process will not fall on wet, newly-coated surfaces.

3.4 SURFACE PREPARATION STANDARDS

A. The following referenced surface preparation specifications of the Steel Structures Painting Council shall form a part of this specification:

1. Solvent Cleaning (SSPC-SP1): Removal of oil, grease, soil, salts, and other soluble contaminants by cleaning with solvent, vapor, alkali, emulsion, or steam.

2. Hand Tool Cleaning (SSPC-SP2): Removal of loose rust, loose mill scale, loose paint, and other loose detrimental foreign matter, by hand chipping, scraping, sanding, and wire brushing.

3. Power Tool Cleaning (SSPC-SP3): Removal of loose rust, loose mill scale, loose paint, and other loose detrimental foreign matter, by power tool chipping, descaling, sanding, wire brushing, and grinding.

4. White Metal Blast Cleaning (SSPC-SP5): Removal of all visible rust, oil, grease, soil, dust, mill scale, paint, oxides, corrosion products and foreign matter by blast cleaning.

5. Commercial Blast Cleaning (SSPC-SP6): Removal of all visible oil, grease, soil, dust, mill scale, rust, paint, oxides, corrosion products, and other foreign matter, except that staining shall be limited to no more than 33 percent of each square inch of surface area.

6. Brush-Off Blast Cleaning (SSPC-SP7): Removal of all visible oil, grease, soil, dust, loose mill scale, loose rust, and loose paint.

7. Near-White Blast Cleaning (SSPC-SP10): Removal of all visible oil, grease, soil, dust, mill scale, rust, paint, oxides, corrosion products, and other foreign matter, except that staining shall be limited to no more than 5 percent of each square inch of surface area.

3.5 METAL SURFACE PREPARATION (UNGALVANIZED)

A. The minimum abrasive blasting surface preparation shall be as indicated in the coating system schedules included at the end of this Section. Where there is a conflict between these specifications and the coating manufacturer's printed recommendations for the intended service, the higher degree of cleaning shall apply.

B. Workmanship for metal surface preparation shall be in conformance with the current SSPC Standards and this Section. Blast cleaned surfaces shall match the standard samples available from the National Association of Corrosion Engineers, NACE Standard TM-01-70 - Visual Standard for Surfaces of New Steel Airblast Cleaned with Sand Abrasive and TM-01-75 - Visual Standard for Surfaces of New Steel Centrifugally Blast Cleaned with Steel Grit.

C. All oil, grease, welding fluxes, and other surface contaminants shall be removed by solvent cleaning per SSPC-SP1 - Solvent Cleaning prior to blast cleaning.

D. All sharp edges shall be rounded or chamfered and all burrs, and surface defects and weld splatter shall be ground smooth prior to blast cleaning.

E. The type and size of abrasive shall be selected to produce a surface profile that meets the coating manufacturer's recommendation for the particular coating and service conditions. Abrasives for submerged and severe service coating systems shall be clean, hard, sharp cutting crushed slag. Automated blasting systems shall not be used for surfaces that will be in submerged service. Metal shot or grit shall not be used for surfaces that will be in submerged service, even if subsequent abrasive blasting is planned to be one with hard, sharp cutting crushed slag.

F. The abrasive shall not be reused unless an automated blasting system is used for surfaces that will be in non-submerged service. For automated blasting systems, clean oil-free abrasives shall be maintained. The abrasive mix shall include at least 50 percent grit.

G. The Contractor shall comply with the applicable federal, state, and local air pollution control regulations for blast cleaning.

H. Compressed air for air blast cleaning shall be supplied at adequate pressure from well maintained compressors equipped with oil and moisture separators which remove at least 95 percent of the contaminants.

I. Surfaces shall be cleaned of all dust and residual particles of the cleaning operation by dry air blast cleaning, vacuuming, or another approved method prior to painting.

J. Enclosed areas and other areas where dust settling is a problem shall be vacuum cleaned and wiped with a tack cloth.

K. Damaged or defective coating shall be removed by the specified blast cleaning to meet the clean surface requirements before recoating.

L. If the specified abrasive blast cleaning will damage adjacent work, the area to be cleaned is less than 100 square feet, and the coated surface will not be submerged in service, then SSPC-SP2 - Hand Tool Cleaning or SSPC-SP3 - Power Tool Cleaning, may be used.

M. Shop applied coatings of unknown composition shall be completely removed before the indicated coatings are applied. Valves, castings, ductile or cast iron pipe, and fabricated pipe or equipment shall be examined for the presence of shop-applied temporary coatings. Temporary coatings shall be completely removed by solvent cleaning per SSPC-SP1 before the abrasive blast cleaning work has been started.

N. Shop primed equipment shall be solvent cleaned in the field before finish coats are applied.

3.6 SURFACE PREPARATION FOR GALVANIZED FERROUS METAL

A. Galvanized ferrous metal shall be alkaline cleaned per SSPC-SP1 to remove oil, grease, and other contaminants detrimental to adhesion of the protective coating system to be used.

B. Pretreatment coatings of surfaces shall be in accordance with the printed recommendations of the coating manufacturer.

3.7 SURFACE PREPARATION OF FERROUS SURFACES WITH EXISTING COATINGS, EXCLUDING STEEL RESERVOIR INTERIORS

A. General: All grease, oil, heavy chalk, dirt, or other contaminants shall be removed by solvent or detergent cleaning prior to abrasive blast cleaning. The generic type of the existing coatings shall be determined by laboratory testing.

B. Abrasive Blast Cleaning: The Contractor shall provide the degree of cleaning specified in the coating system schedule for the entire surface to be coated. If the degree of cleaning is not indicated in the schedule, deteriorated coatings shall be removed by abrasive blast cleaning to SSPC-SP6 - Commercial Blast Cleaning. Areas of tightly adhering coatings shall be cleaned to SSPC-SP7 - Brush-off Blast Cleaning, with the remaining thickness of existing coating not to exceed 3 mils.

C. Incompatible Coatings: If coatings to be applied are not compatible with existing coatings the Contractor shall apply intermediate coatings per the paint manufacturer's recommendation for the indicated coating system or shall completely remove the existing coating prior to abrasive blast cleaning. A small trial application shall be conducted for compatibility prior to painting large areas.

D. Unknown Coatings: Coatings of unknown composition shall be completely removed prior to application of new coatings.

E. Water Abrasive or Wet Abrasive Blast Cleaning: Where specified or where job site conditions do not permit dry abrasive blasting for industrial coating systems due to dust or air pollution considerations, water abrasive blasting or wet abrasive blasting may be used. In both methods, paint-compatible corrosion inhibitors shall be used, and coating application shall begin as soon as the surfaces are dry. Water abrasive blasting shall be done using high pressure water with sand injection. In both methods, the equipment used shall be commercially produced equipment with a successful service record. Wet blasting methods shall not be used for submerged and severe service coating systems unless indicated.

3.8 CONCRETE AND CONCRETE BLOCK MASONRY SURFACE PREPARATION

A. Surface preparation shall not begin until at least 30 days after the concrete or masonry has been placed.

B. All oil, grease, and form release and curing compounds shall be removed by detergent cleaning per SSPC-SP1 before abrasive blast cleaning.

C. Concrete, concrete block masonry surfaces and deteriorated concrete surfaces to be coated shall be abrasive blast cleaned to remove existing coatings, laitance, deteriorated concrete, and to roughen the surface equivalent to the surface of the No. 80 grit flint sandpaper.

D. If acid etching is required by the coating application instructions, the treatment shall be made after abrasive blasting. After etching, rinse surfaces with water and test the pH. The pH shall be between neutral and 8.

E. Surfaces shall be clean and as recommended by the coating manufacturer before coating is started.

F. Unless required for proper adhesion, surfaces shall be dry prior to coating. The presence of moisture shall be determined with a moisture detection device such as Delmhorst Model DB, or equal.

3.9 PLASTIC, FIBER GLASS AND NONFERROUS METALS SURFACE PREPARATION

A. Plastic and fiber glass surfaces shall be sanded or brush off blast cleaned prior to solvent cleaning with a chemical compatible with the coating system primer.

B. Non-ferrous metal surfaces shall be solvent-cleaned SSPC-SP1 followed by sanding or brush-off blast cleaning SSPC-SP7.

C. All surfaces shall be clean and dry prior to coating application.

3.10 EXISTING EXTERIOR STUCCO SURFACES

A. Remove all surface contamination by washing with suitable cleaner, rinse thoroughly and allow to dry.

B. Scrape and sand peeled or checked paint to a sound surface.

C. Sand glossy surfaces dull.

D. Seal stains with acrylic primer.

3.11 SHOP COATING REQUIREMENTS

A. Unless otherwise indicated, all items of equipment, or parts of equipment which are not submerged in service, shall be shop primed and then finish coated in the field after installation with the indicated or selected color. The methods, materials, application equipment and all other details of shop painting shall comply with this section. If the shop primer requires topcoating within a specified period of time, the equipment shall be finish coated in the shop and then touch-up painted after installation.

B. All items of equipment, or parts and surfaces of equipment which are submerged or inside an enclosed hydraulic structure when in service, with the exception of pumps and valves, shall have all surface preparation and coating work performed in the field.

C. The interior surfaces of steel water reservoirs, except for Part A surfaces, shall have all surface preparation and coating work performed in the field.

D. For certain pieces of equipment it may be undesirable or impractical to apply finish coatings in the field. Such equipment may include engine generator sets, equipment such as electrical control panels, switchgear or main control boards, submerged parts of pumps, ferrous metal passages in valves, or other items where it is not possible to obtain the indicated quality in the field. Such equipment shall be primed and finish coated in the shop and touched up in the field with the identical material after installation. The Contractor shall require the manufacturer of each such piece of equipment to certify as part of its shop drawings that the surface preparation is in accordance with these specifications. The coating material data sheet shall be submitted with the shop drawings for the equipment.

E. For certain small pieces of equipment the manufacturer may have a standard coating system which is suitable for the intended service conditions. In such cases, the final determination of suitability will be made during review of the shop drawing submittals. Equipment of this type generally includes only indoor equipment such as instruments, small compressors, and chemical metering pumps.

F. Shop painted surfaces shall be protected during shipment and handling by suitable provisions including padding, blocking, and the use of canvas or nylon slings. Primed surfaces shall not be exposed to the weather for more than 2 months before being topcoated, or less time if recommended by the coating manufacturer.

G. Damage to shop-applied coatings shall be repaired in accordance with this Section and the coating manufacturer’s printed instructions.

H. The Contractor shall make certain that the shop primers and field topcoats are compatible and meet the requirements of this Section. Copies of applicable coating manufacturer's data sheets shall be submitted with equipment shop drawings.

3.12 APPLICATION OF COATINGS

A. The application of protective coatings to steel substrates shall be in accordance with SSPC-PA1 - Paint Application Specification No. 1.

B. Cleaned surfaces and all coats shall be inspected prior to each succeeding coat. The Contractor shall schedule such inspection with the Engineer in advance.

C. Blast cleaned ferrous metal surfaces shall be painted before any rusting or other deterioration of the surface occurs. Blast cleaning shall be limited to only those surfaces that can be coated in the same working day.

D. Coatings shall be applied in accordance with the manufacturer's instructions and recommendations, and this Section, whichever has the most stringent requirements.

E. Special attention shall be given to edges, angles, weld seams, flanges, nuts and bolts, and other places where insufficient film thicknesses are likely to be present. Use stripe painting for these areas.

F. Special attention shall be given to materials which will be joined so closely that proper surface preparation and application are not possible. Such contact surfaces shall be coated prior to assembly or installation.

G. Finish coats, including touch-up and damage repair coats shall be applied in a manner which will present a uniform texture and color matched appearance.

H. Coatings shall not be applied under the following conditions:

1. Temperature exceeding the manufacturer's recommended maximum and minimum allowable.

2. Dust or smoke laden atmosphere.

3. Damp or humid weather.

4. When the substrate or air temperature is less than 5 degrees F above dewpoint.

5. When air temperature is expected to drop below 40 degrees F or less than 5 degrees F above the dewpoint within 8 hours after application of coating.

6. When wind conditions are not calm.

I. Dewpoint shall be determined by use of a sling psychrometer in conjunction with U.S. Dept. of Commerce, Weather Bureau psychometric tables.

J. Unburied steel piping shall be abrasive blast cleaned and primed before installation.

K. The finish coat on all work shall be applied after all concrete, masonry, and equipment installation is complete and the work areas are clean and dust free.

3.13 CURING OF COATINGS

A. The Contractor shall maintain curing conditions in accordance with the conditions recommended by the coating material manufacturer or by this Section, whichever is the most stringent, prior to placing the completed coating system into service.

B. In the case of enclosed areas, forced air ventilation, using heated air if necessary, may be required until the coatings have fully cured.

C. Forced Air Ventilation of Steel Reservoirs and Enclosed Hydraulic Structures: Forced air ventilation is required for the application and curing of coatings on the interior surfaces of steel reservoirs and enclosed hydraulic structures. During application and curing periods, continuously exhaust air from a manhole in the lowest shell ring, or in the case of an

enclosed hydraulic structure, from the lowest level of the structure using portable ducting. After all interior coating operations have been completed, provide a final curing period for a minimum of 10 days, during which the forced ventilation system shall operate continuously.

3.14 IDENTIFICATION OF PIPING

A. Identification of piping shall be in accordance with Section 15005 - Piping Identification Systems.

B. Every valve or connection, where it may be possible for a worker to be exposed to a hazardous substance, shall be labeled per General Industry Safety Orders, Articles 112 and 5194.

C. All unburied pipe, pipe in structures and pipe in chemical pipe trenches shall be color-code painted. Colors shall be as selected by the Engineer, as indicated, or as specified in Section 15005 – Piping Identification.

3.15 SHOP AND FIELD INSPECTION AND TESTING

A. General: The Contractor shall give the Engineer a minimum of 3 days advance notice of the start of any field surface preparation work or coating application work, and a minimum of 7 days advance notice of the start of any shop surface preparation work.

B. All such work shall be performed only in the presence of the Engineer, unless the Engineer has granted prior approval to perform such work in its absence.

C. Inspection by the Engineer, or the waiver of inspection of any particular portion of the Work, shall not relieve the Contractor of its responsibility to perform the work in accordance with these Specifications.

D. Scaffolding shall be erected and moved to locations where requested by the Engineer to facilitate inspection. Additional illumination shall be furnished to cover all areas to be inspected.

E. Inspection Devices: The Contractor shall furnish, until final acceptance of such coatings, inspection devices in good working condition for the detection of holidays and measurement of dry-film thicknesses of protective coatings. Dry-film thickness gages shall be made available for the Engineer's use at all times while coating is being done, until final acceptance of such coatings. The Contractor shall furnish the services of a trained operator of the holiday detection devices until the final acceptance of such coatings. Holiday detection devices shall be operated only in the presence of the Engineer.

F. Holiday Testing: The Contractor shall holiday test all coated ferrous surfaces inside a steel reservoir, other surfaces which will be submerged in water or other liquids, or surfaces which are enclosed in a vapor space in such structures and surfaces coated with any of the submerged and severe service coating systems. Areas which contain holidays shall be marked and repaired or recoated in accordance with the coating manufacturer's printed instructions and then retested.

1. Coatings With Thickness Exceeding 20 Mils: For surfaces having a total dry film coating thickness exceeding 20 mils: pulse-type holiday detector such as Tinker & Rasor Model AP-W, D.E. Stearns Co. Model 14/20, or equal shall be used. The unit shall be adjusted to operate at the voltage required to cause a spark jump

across an air gap equal to twice the specified coating thickness or 100 volts per mil, whichever is greater.

2. Coatings With Thickness of 20 Mils or Less: For surfaces having a total dry film coating thickness of 20 mils or less: Tinker & Rasor Model M1 non-destructive type holiday detector, K-D Bird Dog, or equal shall be used. The unit shall operate at less than 75-volts. For thicknesses between 10 and 20 mils, a non-sudsing type wetting agent, such as Kodak Photo-Flo, or equal**,** shall be added to the water prior to wetting the detector sponge.

G. Film Thickness Testing: On ferrous metals, the dry film coating thickness shall be measured in accordance with the SSPC "Paint Application Specification No. 2" using a magnetic-type dry film thickness gage such as Mikrotest model FM, Elcometer model 111/1EZ, or equal**.** Each coat shall be tested for the correct thickness. No measurements shall be made until at least 8 hours after application of the coating. On non-ferrous metals and other substrates, the coating thicknesses shall be measured at the time of application using a wet film gage.

H. Surface Preparation: Evaluation of blast cleaned surface preparation work will be based upon comparison of the blasted surfaces with the standard samples available from the NACE, using NACE standards TM-01-70 and TM-01-75.

I. Adhesion Testing: The adhesion tests shall be performed on a minimum of once per fifty (50) continuous square feet of coated surface area. Adhesion testing shall be conducted after the liner system has cured per manufacturer instruction and in accordance with ASTM D4541 as modified herein. A minimum of one 20 mm dolly shall be affixed to the lined surface of the structure at the upper section or cone area, mid section and at the bottom. Each testing location shall be identified by the Engineer. The adhesive used to attach the dollies to the liner shall be rapid setting with tensile strength in excess of the liner material and permitted to cure in accordance with manufacturer recommendations. The lining material and dollies shall be adequately prepared to receive the adhesive. Prior to pull test, the Contractor shall utilize a scoring device to cut through the coating until the substrate is reached. Extreme care shall be required while scoring to prevent micro cracking in the coating, since cracks may cause failures at diminished strengths. Failure due to improper dolly adhesive or scoring shall require retesting. The pull tests in each area shall meet or exceed 200 psi. and shall include subbase adhered to the back of the dolly or no visual signs of coating material in the test hole. Pull tests with results between a minimum 150 psi and 200 psi shall be acceptable if more than 50% of the subsurface is adhered to the back of the dolly. A test result can be discarded, as determined by the Engineer, if there is a valid nonstatistical reason for discarding the test results as directed by Sections 8.4 and 8.5 of ASTM D4541. If any test fails, a minimum of three additional locations in the section of the failure shall be tested, as directed by the Engineer. If any of the retests fail all loosely adhered or unadhered liner in the failed area, as determined by the Engineer, shall be removed and replaced at the Contractor's expense. If a structure fails the adhesion test, one additional structure or 10% of the initial number of structures selected for testing shall be tested at the discretion of the Engineer.

3.16 COATING SYSTEM SCHEDULES

A. General

1. Pretreatment coatings, barrier coatings or washed for galvanized ferrous metal surfaces, and the exterior of welded steel tanks, shall be applied as

recommended by the coating manufacturer. All galvanized surfaces shall be coated except for the following items which shall be coated only if required by other Sections: (1) floor gratings and frames, (2) handrails, (3) stair treads, (4) chain link fences and appurtenances.

2. Where isolated non-ferrous metal, plastic or fiberglass parts are associated with equipment or piping, the Contractor shall use the coating system for the adjacent connected surfaces. Do not coat handrails, gratings, frames or hatches unless required by other sections. Only primers recommended by the coating manufacturer shall be used.

B. Coating Schedules

1. Coating System Schedule – Submerged or Immersed Surfaces

Item	**Surface Prep.**	**System No.**
Surfaces of equipment and ungalvanized ferrous surfaces submerged or intermittently submerged in potable water, utility water, recycled water, and wastewater including all surfaces below 2 feet above high water level in hydraulic structures and all surfaces inside enclosed hydraulic structures and vents (excluding shop-coated valves, couplings, pumps)	White metal blast cleaning SSPC-SP5	(100) amine-cured epoxy
Ungalvanized ferrous surfaces in water passages of all valves 4-inch size and larger, exterior surfaces of submerged valves	White metal blast cleaning SSPC-SP5	(102) polyamide-cured epoxy
Ungalvanized ferrous surfaces in water passages and submerged surfaces of all pumps which have discharge size of 4-inches or larger	White metal blast cleaning SSPC-SP5	(100) amine-cured epoxy
All ungalvanized ferrous surfaces of sluice gates, flap gates and shear gates including wall thimbles	White metal blast cleaning SSPC-SP5	(102) polyamide-cured epoxy
Surfaces of galvanized ferrous metals submerged in water or wastewater, including all surfaces lower than 2 feet above high water level and all surfaces inside enclosed hydraulic structures and vents	Alkaline cleaning SSPC-SP1 followed by brush-off grade blast cleaning SSPC-SP7	(100) amine-cured epoxy
Interior surfaces of welded steel tank for storage of water, potable water, recycled water or utility water	White metal blast cleaning SSPC-SP5	(100) amine-cured epoxy
Concrete block masonry surfaces submerged in water or wastewater including all vertical masonry	Per paragraph 3.8	(204) water-

surfaces above water line as indicated.	retardant

2. Coating System Schedule – Buried Surfaces

Item	Surface Prep.	System No.
Buried small steel (ungalvanized and galvanized) pipe	Removal of dirt, grease, oil	(200) PVC tape
Buried ungalvanized ferrous metal surfaces that are not indicated to be coated elsewhere	Near white metal blast cleaning SSPC-SP10	(100) amine-cured epoxy
Buried ungalvanized ferrous pipe couplings, valves, fittings and flanged joints (where piping is plastic)	Removal of dirt, grease, oil	(106) Fusion bonded epoxy (205) polyethylene encasement
Buried ungalvanized ferrous pipe couplings, valves, fittings and flanged joints (where piping is ductile or cast iron, not tape coated), including epoxy-coated surfaces	As specified by reference section	(106) Fusion bonded epoxy (205) polyethylene encasement
Buried ungalvanized ferrous pipe couplings, valves, fittings and flanged joints (where piping is mortar coated steel or reinforced concrete) including epoxy-coated surfaces	Removal of dirt, grease, oil	(206) cement-mortar coating
Buried galvanized ferrous surfaces	Alkaline cleaning SSPC-SP1 followed by brush-off grade blast cleaning SSPC-SP7	(100) amine-cured epoxy
Buried non-ferrous metal pipe	Removal of dirt, grease, oil	(200) PVC tape

3. Coating System Schedule – Exposed Surfaces

Item	Surface Prep.	System No.
Structural ungalvanized steel, miscellaneous metalwork, and supports for roof and facia support systems for buildings.	Commercial blast cleaning SSPC-SP6	(4) aliphatic polyurethane
Surfaces of indoor ungalvanized ferrous equipment, not submerged.	Commercial blast cleaning SSPC-SP6	(8) epoxy, equipment
Exposed polyvinyl chloride plastic piping, indoors and outdoors or in	Solvent cleaned SSPC-SP1	(7)

structures, not submerged.		acrylic latex
Concrete floor slabs and walls exposed to chemicals, ferric chloride, as indicated.	Per paragraph 3.8	(203) epoxy surfacing
Exposed wood, indoors and outdoors	Per manufacturer's printed instructions	209 or 210
Exposed concrete masonry unit	Per paragraph 3.8	(204) water retardant
Exposed ferrous metal piping	Commercial blast cleaning SSPC-SP6	(4) aliphatic polyurethane

4. Coating System Schedule – Misc.

Item	**Surface Prep.**	**System No.**
Ungalvanized ferrous surfaces exposed to high temperatures (150 to 600 degrees F)	Near white metal blast cleaning SSPC-SP10	(6) inorganic zinc, water-based
Ungalvanized ferrous surfaces exposed to high temperatures (600 to 1000 degrees F)	Near white metal blast cleaning SSPC-SP10	(3) aluminum silicone resin
Interior surfaces of all ungalvanized ferrous in connection chemical tanks, including nozzles, manholes, nozzle necks, flange faces	White metal blast cleaning SSPC-SP5	(107) chemical-resistant sheet lining
Aluminum surfaces in contact with concrete, or with any other metal except galvanized ferrous metal	Solvent cleaned SSPC-SP1	(208) aluminum metal isolation
Drywall	Per manufacturer's printed instructions	(211) acrylic-drywall
Interior concrete masonry unit walls exposed to chemical splash or washdown, as indicated	Per paragraph 3.8	(11) aliphatic polyurethane, concrete
Existing Exterior Stucco	Per paragraph 3.10	(212)

END OF SECTION

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SECTION 10400 – IDENTIFYING DEVICES

PART 1 GENERAL

1.1 THE REQUIREMENT

A. The Contractor shall provide signs and other identifying devices and all appurtenant work, complete and in place, in accordance with the Contract Documents.

B. Identifying devices required by other Section of the Specifications shall also comply with this Section.

1.2 CONTRACTOR SUBMITTALS

A. General: The Contractor shall furnish submittals in accordance with the requirements of Section 01340 – Shop Drawings, Product Data, and Samples.

B. Shop Drawings: Full-size or scaled layouts of signs showing sign size, color, fasteners and mounting, and location. A typical of repetitive sign layouts may be submitted. Most restrictive conditions shall be depicted.

C. Samples: Samples of all the materials and colors proposed for the Work, clearly marked to show the manufacturer's name and product identification along with the manufacturer's technical data and application instructions.

PART 2 PRODUCTS

2.1 GENERAL

A. Identification devices shall be installed where directed by the Engineer. All wording shall be as indicated and shall be verified before fabrication.

2.2 BUILDING/ ROOM NAMEPLATES

A. Nameplates shall be Builders Brass Works, Vornar Products, Inc., or equal, with colored 1/8-inch acrylic plastic (matte finish). Lettering shall be white, 1/2-inch high, or 36 points, and shall be fused by heat and pressure to a depth of approximately 0.005-inch. Plates shall be installed in an extruded aluminum frame, medium bronze or dark anodized finish, and be provided with 2-way adhesive mounting tape. Plastic color and letter style shall be as selected by the Engineer. Provide and install a total of 8 nameplates to be defined and selected by the Engineer.

2.3 IDENTIFICATION OF PIPING

A. Identification of all exposed pipe shall be provided by application of color coded labels and arrows of adhesive-backed vinyl cloth. Adhesive will be recommended by the manufacturer for application to the specified coating systems.

1. Each pipe identification shall have a preprinted label to identify the contents of the pipe and a matching flow arrow to indicate direction of flow. Colors and labels shall be as listed in the Pipe Schedule. Labels and flow arrows shall be provided

at intervals not exceeding 20 feet, at all branches and tees, and wherever pipes enter or emerge from walls or enter a structure from above or through the floor.

2. Letter sizes and coloring for lettering shall conform to ANSI A13.1.

3. Preprinted identification devices shall be as manufactured by W.H. Brady Co., Seton Nameplate Corp., or equal.

B. All unburied pipe, pipe in structures, and pipe in chemical pipe trenches shall be color-code painted. Colors shall be as selected by Engineer, and as indicated in the Section 15005 – Piping Identification. The finish coat colors shall match the existing colors as closely as possible, except where the Engineer directs otherwise. The color code painting shall include all valves, supports, equipment and appurtenances to the piping system.

2.4 EQUIPMENT, TANKS, VALVE, AND GATE IDENTIFICATION

A. All equipment, tanks, valves, and gate with P&ID tag numbers and names shall be installed with labels (after finish painting). The label shall include the P&ID tag, and the common name (ie WAS Pump). Identification of shall be provided by application of labels of adhesive-backed vinyl cloth. Adhesive will be recommended by the manufacturer for application to the specified coating systems.

1. Each identification shall have a preprinted label to identify the item.

2. Letter sizes shall be 1 in for equipment and gates, 2 in for tanks, ½ in for valves and small equipment.

3. Preprinted identification devices shall be as manufactured by W.H. Brady Co., Seton Nameplate Corp., or equal.

2.5 SIGNS

A. General: Signs or warning shall be enamel painted on semi-rigid butyrate. Signs shall conform to OSHA Standards and directions. Lettering sizes shall be 3-inch in height unless indicated otherwise.

B. Ferric Chloride and sodium hypochlorite storage tank inlets and outlets shall be clearly marked with hazardous material warning signs 10-inches by 14-inches in size.

C. Signs of the following sign shall be provided for installation where directed by the Engineer unless specified below:

Signs	**Location(s)**	**Quantity**
NO SMOKING		Five (5) Signs
EXIT	At all required exits	Thirteen (13) Signs
CAUTION VENTILATE BEFORE ENTERING		Five (5) Signs

DANGER PERMIT REQUIRED CONFINED SPACE		Five (5) Sign
DO NOT ENTER		Five (5) Signs
CAUTION NON-POTABLE WATER DO NOT DRINK		Fifteen (15) Signs
WARNING THIS EQUIPMENT STARTS AUTOMATICALLY		Twenty (20) Signs
CAUTION: PRESSURE RELIEF DEVICE LOCATED ABOVE. NO LOITERING IN AREA	Adjacent to the area below the deflagration deflector located on the east side of the Dryer Building	Two (2) Signs
CAUTION: LOW CLEARANCE	Areas of the Dryer Building where pipe or equipment is below 7'-6" in height above finished floor and where operation and maintenance staff will need to access.	Five (5) Signs
CAUTION: HOT SURFACE AREA. DO NOT ACCESS UNTIL DRYER SYSTEM HAS COOLED DOWN.	Gate located on the platform that provides access to the Dried Solids Return Conveyor.	One (1) Sign
CAUTION: HOT SURFACE. DO NOT TOUCH	Locations at Biosolids Dryer to be determined in the field by Owner.	Five (5) Signs
To be Determined During Construction	To be determined during construction	Twenty (20) Signs

2.6 LETTERS

A. Metal: Letters shall be a 3-inch anodic finish aluminum of medium bronze 312E color. The letters shall be of "Futura" design as manufactured by James H. Matthews and Co., or equal. Letters shall be provided complete with fasteners for concrete wall or metal wall panel installation as indicated in the following Areas at locations to be determined by Owner.

1. Area 23: AERATION BASIN NO. 3 (Quantity – 1), AERATION BASIN NO. 4 (Quantity – 1)

2. Area 27: PUMP MAINTENANCE SHOP (Quantity – 1), ELECTRICAL ROOM (Quantity – 1), BLOWER ROOM (Quantity – 1)

3. Area 51: WAS STORAGE (Quantity – 1)

4. Area 52: BIOSOLIDS DRYER (Quantity – 2)

5. Area 53: BIOSOLIDS STORAGE (Quantity – 2)

PART 3 EXECUTION

3.1 GENERAL

A. All installation of identifying devices shall be vandal-resistant. Fasteners shall be concealed, non-corrosive fasteners appropriate for materials being fastened and as required.

3.2 LETTERS

A. Installation of metal letters shall be 3/4-inch projection mounted from concrete block wall surface with threaded studs and space collars. The center of each row shall align. Letters shall be installed per manufacturer's published instructions.

END OF SECTION

SECTION 10520 - FIRE EXTINGUISHERS AND CABINETS

PART 1 - GENERAL

1.1 SUBMITTALS

A. Submit fully detailed shop drawings giving sizes, methods of attachment, and all required accessories. Submit manufacturer's data for all items supplied under this section of work.

1.2 PRODUCT DELIVERY, STORAGE AND HANDLING

A. Pack accessories individually in a manner to protect accessory and its finish.

B. Protect adjacent or adjoining finished surfaces and work from damage during installation of work of this section.

PART 2 PRODUCTS

2.1 FIRE EXTINGUISHER CABINET AND FIRE EXTINGUISHER

A. Fire extinguisher cabinet shall be surface-mounted, steel cabinet with clear anodized aluminum door and door frame, with full panel viewing door cover. The size shall be as necessary to hold fire extinguisher specified or shown at cabinet location.

B. Fire Extinguisher: Larsen's Manufacturing Co., MP10 or equal. Provide quantity as indicated on Contract Drawings.

PART 3 EXECUTION

3.1 PREPARATION

A. Deliver inserts and rough-in frames to jobsite at appropriate time for building-in. Provide templates and rough-in measurements as required.

B. Before starting work, notify Engineer in writing of any conflicts detrimental to installation or operation of units.

C. Verify with Engineer exact location of accessories.

3.2 INSTALLATION

A. Install fire extinguishers and fire extinguisher cabinets in accordance with approved shop drawings.

B. Install true, plumb and level, securely and anchored to substrate.

C. Provide approved identification to meet City and State Fire Marshal's requirements.

END OF SECTION

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PART G – Technical Specifications

City of Brentwood
Brentwood, California

FOR THE CONSTRUCTION OF THE

WASTEWATER TREATMENT PLANT EXPANSION – PHASE II

PROJECT NO. 592-59140

Volume 2 of 3
Technical Specifications Divisions 11 - 15

January 2020

In Association with

TJC and Associates, Inc.

Burks Toma Architects

Black and Veatch

RHAA Landscape Architects

SEMCO Consultants, Inc.

JDH Corrosion Consultants

Cal Engineering and Geology, Inc.

HYT Corporation

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RESPONSIBLE ENGINEER SEALS AND SIGNATURES

DIVISION 01 – GENERAL REQUIREMENTS

REGISTERED PROFESSIONAL ENGINEER
ANTHONY T. VALDIVIA
No. 66847
Exp. 09-30-20
CIVIL
STATE OF CALIFORNIA

REGISTERED PROFESSIONAL ENGINEER
RICHARD KERR THOW
No. 5620
EXP. 09/30/21
STRUCTURAL
STATE OF CALIFORNIA

DIVISION 02 – SITEWORK

REGISTERED PROFESSIONAL ENGINEER
ANTHONY T. VALDIVIA
No. 66847
Exp. 09-30-20
CIVIL
STATE OF CALIFORNIA

REGISTERED PROFESSIONAL ENGINEER
DANIEL J. PELUSO
GE 2367
GEOTECHNICAL
STATE OF CALIFORNIA

LICENSED LANDSCAPE ARCHITECT
Barbara D. Lundburg License No. 1697
Signature
3-31-20
Renewal Date
3-5-19
Date
STATE OF CALIFORNIA

DIVISION 03 – CONCRETE

REGISTERED PROFESSIONAL ENGINEER
RICHARD KERR THOW
No. 5620
EXP. 09/30/21
STRUCTURAL
STATE OF CALIFORNIA

DIVISION 04 – MASONRY – Not Used

DIVISION 05 – METALS

REGISTERED PROFESSIONAL ENGINEER
RICHARD KERR THOW
No. 5620
EXP. 09/30/21
STRUCTURAL
STATE OF CALIFORNIA

DIVISION 06 – WOOD AND PLASTICS

LICENSED ARCHITECT
KAREN BURKS
NO. C-12893
EXP. 10/31/21
ARCHITECT
STATE OF CALIFORNIA

DIVISION 07 – THERMAL AND MOISTURE PROTECTION

LICENSED ARCHITECT
KAREN BURKS
NO. C-12893
EXP. 10/31/21
ARCHITECT
STATE OF CALIFORNIA

DIVISION 08 – DOORS AND WINDOWS

LICENSED ARCHITECT
KAREN BURKS
NO. C-12893
EXP. 10/31/21
ARCHITECT
STATE OF CALIFORNIA

DIVISION 09 – FINISHES

LICENSED ARCHITECT
KAREN BURKS
NO. C-12893
EXP. 10/31/21
ARCHITECT
STATE OF CALIFORNIA

REGISTERED PROFESSIONAL ENGINEER
ANTHONY T. VALDIVIA
No. 66847
Exp. 09-30-20
CIVIL
STATE OF CALIFORNIA

DIVISION 10 – SPECIALTIES

REGISTERED PROFESSIONAL ENGINEER
ANTHONY T. VALDIVIA
No. 66847
Exp. 09-30-20
CIVIL
STATE OF CALIFORNIA

DIVISION 11 – EQUIPMENT

REGISTERED PROFESSIONAL ENGINEER
ANTHONY T. VALDIVIA
No. 66847
Exp. 09-30-20
CIVIL
STATE OF CALIFORNIA

REGISTERED PROFESSIONAL ENGINEER
JESSE W. WALLIN
C77408
CIVIL
STATE OF CALIFORNIA
08/14/19

DIVISION 12 – FURNISHINGS – Not Used

DIVISION 13 – SPECIAL CONSTRUCTION

REGISTERED PROFESSIONAL ENGINEER
ANTHONY T. VALDIVIA
No. 66847
Exp. 09-30-20
CIVIL
STATE OF CALIFORNIA

REGISTERED PROFESSIONAL ENGINEER
RICHARD KEER THOW
No. S 5626
EXP. 09/30/21
STRUCTURAL
STATE OF CALIFORNIA

REGISTERED PROFESSIONAL ENGINEER
PAUL J. GIORSETTO
No. E 11674
Exp. 09/30/20
ELECTRICAL
STATE OF CALIFORNIA

REGISTERED PROFESSIONAL ENGINEER
MOHAMMED ALI
No. CR 1035
Exp. June 30, 2019
CORROSION
STATE OF CALIFORNIA

DIVISION 14 – CONVEYING SYSTEMS

REGISTERED PROFESSIONAL ENGINEER
ANTHONY T. VALDIVIA
No. 66847
Exp. 09-30-20
CIVIL
STATE OF CALIFORNIA

DIVISION 15 – MECHANICAL

REGISTERED PROFESSIONAL ENGINEER
ANTHONY T. VALDIVIA
No. 66847
Exp. 09-30-20
CIVIL
STATE OF CALIFORNIA

REGISTERED PROFESSIONAL ENGINEER
BRET B. TRESIDDER
No. 1165
Exp. 09/30/20
FIRE PROTECTION
STATE OF CALIFORNIA

DIVISION 16 – ELECTRICAL

REGISTERED PROFESSIONAL ENGINEER
PAUL J. GIORSETTO
No. E 11674
Exp. 09/30/20
ELECTRICAL
STATE OF CALIFORNIA

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CITY OF BRENTWOOD
Brentwood, California

WASTEWATER TREATMENT PLANT EXPANSION - PHASE II

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SECTION 11100 – PUMPS, GENERAL

PART 1 GENERAL

1.1 THE REQUIREMENT

A. The CONTRACTOR shall provide all pumps, motors and pumping appurtenances, complete and operable, in accordance with the Contract Documents. The provisions of this Section shall apply to all pumps and pumping equipment except where otherwise indicated in the Contract Documents.

B. The requirements of Section 11000 – Equipment, General are applicable to this section.

1.2 REFERENCE SPECIFICATIONS, CODES, AND STANDARDS

ASTM A48	Specification for Gray Iron Castings
ASTM B62	Specification for Composition Bronze or Ounce Metal Castings
ASTM B584	Specification for Copper Alloy Sand Castings for General Applications.
ANSI/ASME B16.1	Cast Iron Pipe Flanges and Flanged Fittings
ANSI/IEEE 112	Test Procedure for Polyphase Induction Motors and Generators
ANSI/IEEE 115	Test Procedure for Synchronous Machines
ANSI/HI 1.6	American National Standard for Centrifugal Pump Tests
ANSI/HI 2.6	American National Standard for Vertical Pump Tests

1.3CONTRACTOR SUBMITTALS

A. General: CONTRACTOR shall submit administrative, shop drawings, samples, quality control, and contract closeout submittals of all equipment furnished this Section and in referenced Sections in accordance with the requirements of Section 01340 Shop Drawings, Product Data and Samples.

B. Shop Drawings and Samples: In addition to the requirements of Section 01340, CONTRACTOR shall submit the following:

1. Pump name, identification number, and Specification Section number.

2. Performance data curves showing head, capacity, horsepower demand, NPSH required, and pump efficiency over the entire operating range of the pump. The equipment manufacturer shall indicate separately the head, capacity, horsepower demand, overall efficiency, and minimum submergence required at the design flow conditions and the maximum and minimum flow conditions. A family of performance curves at intervals of 100 rpm from minimum speed to maximum

speed shall be provided for each centrifugal pump equipped with a variable speed drive.

3. The CONTRACTOR shall require the Manufacturer to indicate the limits on the performance curves recommended for stable operation without surge, cavitation, or excessive vibration. The stable operating range shall be as wide as possible based on actual hydraulic and mechanical tests.

4. Assembly and installation drawings including shaft size, seal, coupling, bearings, anchor bolt plan, part nomenclature, material list, outline dimensions, and shipping weights.

5. Data, in accordance with Section 16220 – Low Voltage Motors, for the electric motor proposed for each pump.

6. Elevation of proposed Local Control Panel showing panel-mounted devices, details of enclosure type, single line diagram of power distribution, and current draw of panel, and list of all terminals required to receive inputs or to transmit outputs from the Local Control Panel.

7. Wiring diagram of field connections with identification of terminations between Local Control Panels, junction terminal boxes, and equipment items.

8. Complete electrical schematic diagram.

9. Torsional Analysis

C. O & M Manuals: The CONTRACTOR shall provide operations and maintenance data for all equipment furnished for the project in accordance with Section 01730, Operation and Maintenance Data. Prior to start up the CONTRACTOR shall furnish six copies of the Operations and Maintenance Manuals for each pump Section.

D. Tools: Special tools necessary for maintenance and repair of the equipment shall be furnished as a part of the WORK hereunder; such tools shall be suitably stored in metal tool boxes, and identified with the equipment number by means of stainless steel or solid plastic name tags attached to the box.

E. Quality Assurance: CONTRACTOR shall submit the following:

1. Manufacturer’s Certificate of Proper Installation

2. Functional and Performance Test Results and Certifications

3. Factory performance test reports:

   a. Signed, dated, and certified factory test data for each pump system which requires factory testing, submitted before shipment of equipment.

4. Special shipping, storage and protection, and handling instructions

5. Manufacturer’s printed installation instructions

6. List of suggested spare parts to maintain the equipment in service for a period of 5 years. Include a list of special tools required for checking, testing, parts

replacement, and maintenance. Spare Parts List shall contain the furnished spare parts for each pump Section.

7. List of special tools, materials, and supplies furnished with equipment for use prior to and during startup.

8. Certified pump performance curves for each pump section signed by officer of manufacturer. Certification to include manufactures guarantee performance of flow, head, and efficiency at specified conditions.

9. The CONTRACTOR shall obtain and submit written certification from the designated single manufacturer, addressed to the OWNER, stating that the equipment will efficiently and thoroughly perform the required functions in accordance with these Specifications and as shown, and that the designated single manufacturer accepts the CONTRACTOR'S assignment of full responsibility for coordination of all equipment, including operators and controls, and services required for proper installation and operation. The CONTRACTOR shall submit all such certificates to the ENGINEER.

10. Torsional and Vibrational Analysis

1.4 QUALITY ASSURANCE

A. Fabrication, delivery, and installation shall be in accordance with applicable Hydraulic Institute Standards and requirements.

B. Pumps are to be engineered and manufactured under a Manufacturer's written Quality Assurance program. The Quality Assurance program is to be in effect for at least (5) years, to include a written record for periodic internal and external audits to confirm compliance with such program.

C. Warranty

1. A written suppliers warranty shall be provided for the equipment specified in this section as required in Section 11.2, General Conditions.

1.5 MANUFACTURER'S SERVICE REPRESENTATIVE

A. Manufacturer's Representative. In accordance with the requirements of Section 01660, a Manufacturer's Representative shall be present at the site or classroom designated by the OWNER to provide the services and minimum person-days listed in the individual pump sections, travel time excluded.

B. Inspection, installation assistance, functional and performance testing: Where required by the individual pump Sections, an authorized service representative of the manufacturer shall visit the site for the time indicated in those Sections to witness the following and to certify in writing that the equipment and controls have been properly installed, aligned, lubricated, adjusted, and readied for operation.

1. Installation of the equipment.

2. Inspection, checking, and adjusting the equipment.

3. Startup and field functional and performance testing for proper operation.

4. Performing field adjustments to ensure that the equipment installation and operation comply with requirements.

C. Pre-startup training of the OWNER's Personnel:

1. Where required by the individual pump Sections, an authorized training representative of the manufacturer shall visit the site for the time indicated in those Sections to instruct the OWNER's personnel in the operation and maintenance of the equipment, including step-by-step troubleshooting with necessary test equipment. Instruction shall be specific to the models of equipment provided.

2. The representative shall have at least two year's experience in training. A resume for the representative shall be submitted.

3. Training shall be scheduled as specified in 01660 – Testing and Training.

4. Proposed training material and a detailed outline of each lesson shall be submitted for review as specified in 01660 – Testing and Training. Comments shall be incorporated into the material.

5. The training materials shall remain with the trainees.

6. The OWNER may videotape the training for later use with the OWNER's personnel.

D. A work day is defined as an eight hour period at the site, excluding travel time.

E. The ENGINEER may require that the inspection, startup, and field adjustment and train services to be furnished over separate trips for each pump Section as specified in each pump Section.

PART 2 PRODUCTS

2.1 GENERAL

A. Compliance with the requirements of the individual pump Sections may necessitate modifications to the manufacturer's standard equipment.

B. All components of each pump system provided under the pump Sections shall be entirely compatible. Each unit of pumping equipment shall incorporate all basic mechanisms, couplings, electric motors or engine drives, variable speed controls, necessary mountings, and appurtenances.

C. Performance Curves: All centrifugal pump curves shall be continuously rising from maximum flow to the shutoff.

2.2 PUMP SCHEDULE

PUMP NO.	PUMP NAME	LOCATION	PUMP TYPE
21-P-04-ML	WALL PUMP NO. 1-1	OXIDATION DITCH NO. 1	SUBMERSIBLE PROPELLER
21-P-05-ML	WALL PUMP NO. 1-2	OXIDATION DITCH NO. 1	SUBMERSIBLE PROPELLER
22-P-04-ML	WALL PUMP NO. 2-1	OXIDATION DITCH NO. 2	SUBMERSIBLE PROPELLER
22-P-05-ML	WALL PUMP NO. 2-2	OXIDATION DITCH NO. 2	SUBMERSIBLE PROPELLER
23-P-01-ML	WALL PUMP NO. 3-1	AERATION BASIN NO. 3	SUBMERSIBLE PROPELLER
24-P-01-ML	WALL PUMP NO. 4-1	AERATION BASIN NO. 4	SUBMERSIBLE PROPELLER
	WALL PUMP SHELF SPARE	SHELF SPARE	SUBMERSIBLE PROPELLER
36-P-01-PD	RAS PUMP STATION SUMP PUMP NO. 3	RAS PUMP STATION NORTH	SUBMERSIBLE NON-CLOG
36-P-02-PD	RAS PUMP STATION SUMP PUMP NO. 4	RAS PUMP STATION NORTH	SUBMERSIBLE NON-CLOG
36-P-02-RAS	RAS PUMP NO. 5	RAS PUMP STATION NORTH	HORIZONTAL NON-CLOG
36-P-03-RAS	RAS PUMP NO. 6	RAS PUMP STATION NORTH	HORIZONTAL NON-CLOG
36-P-01-S	SECONDARY SCUM PUMP NO. 3	RAS PUMP STATION NORTH	PROGRESSIVE CAVITY
36-P-02-S	SECONDARY SCUM PUMP NO. 4	RAS PUMP STATION NORTH	PROGRESSIVE CAVITY
61-P-03-SE	FILTER FEED PUMP NO. 3	FILTER FEED PUMP STATION	SUBMERSIBLE NON-CLOG

2.3 PUMP COMPONENTS

A. All materials shall be suitable for the intended application; materials not specified shall be high-grade, standard commercial quality, free from all defects and imperfection that might affect the serviceability of the product for the purpose for which it is intended, and shall conform to the following requirements:

B. Cast iron pump casings and bowls shall be of close-grained gray cast iron, conforming to ASTM A48 - Gray Iron Castings, Class 30, or equal.

C. Bronze pump impellers shall conform to ASTM B62 - Composition Bronze or Ounce Metal Castings, or B584 - Copper Alloy Sand Castings for General Applications, where dezincification does not exist.

D. Stainless steel pump shafts shall be Type 416 or 316. Miscellaneous stainless steel parts shall be of Type 316, except in a septic environment.

E. Anchor bolts, washers, and nuts in Standard Service (Non-Corrosive Application) shall be galvanized steel in accordance with the requirements of Section 05500 – Metal Fabrications. Anchor bolts, washers, and nuts in Corrosive Service as defined in Section 05500 shall be stainless steel in accordance with that Section.

F. Flanges: Suction and discharge flanges shall conform to ANSI/ASME B16.1 - Cast Iron Pipe Flanges and Flanged Fittings, Class 25, 125, 250, and 800 or B16.5 - Pipe Flanges and Flanged Fittings dimensions.

G. Lubrication: Vertical pump shafts of clean water pumps shall be product water-lubricated, unless otherwise indicated. Deep-well pumps and pumps with dry barrels shall have water- or oil-lubricated bearings and seals and enclosed lineshafts. Pumps for sewage, sludge, and other process fluids shall be lubricated as indicated.

H. Handholes: Handholes on pump casings shall be shaped to follow the contours of the casing to avoid any obstructions in the water passage.

I. Vortex Suppressors: Vertical pumps with marginal submergence shall be provided with vortex suppressors.

J. Drains: All gland seals, air valves, cooling water drains, and drains from variable speed drive equipment shall be piped to the nearest floor sink, or drain, with galvanized steel pipe or copper tube, properly supported with brackets.

K. Grease Lubrication: For all vertical propeller, mixed-flow, and turbine pumps, other than deep well pumps, of bowl sizes 10-inches and larger, the CONTRACTOR shall provide a stainless steel tube attached to the column for grease lubrication of the bottom bearing.

L. Stuffing Boxes: Where stuffing boxes are specified for the pump seal, they shall be of the best quality, using the manufacturer's suggested materials best suited for the specific application. For sewage, sludge, drainage, and liquids containing sediments, the seals shall be flushed as shown on the drawings, using lantern rings.

1. Unless otherwise indicated, the packing material shall be interlaced Teflon braiding, containing 50 percent ultrafine graphite impregnation to satisfy the following:

2. Shaft Speeds: Up to 2,500 fpm.

3. Temperature: Up to 500 degrees F.

4. pH Range: 0-14.

5. If fresh water is not available, the seal shall be flushed with utility water from the plant’s utility water system.

M. Mechanical Seals: Mechanical seals shall be flushed as indicated in the contract drawings. Mechanical seals shall be as manufactured by the following, unless indicated differently in the individual pump sections, in which case seals shall be as indicated in the individual pump sections:

1. The pumps listed in the following table shall have one of the seal types as listed in the table.

Pump Tag	Pump Type	Chesterton Seal	John Crane Seal
36-P-02-RAS	HORIZONTAL NON-CLOG	S20	5620
36-P-03-RAS	HORIZONTAL NON-CLOG	S20	5620
36-P-01-S	PROGRESSIVE CAVITY	S20	5620
36-P-02-S	PROGRESSIVE CAVITY	S20	5620

2. All other pumps shall have one of the following seals:

    1) Chesterton mechanical split cartridge type, Chesterton 442.
    2) John Crane mechanical split cartridge type, John Crane 3710

3. Where indicated, a buffer fluid must be circulated a minimum 20 psi above discharge pressure, or as required by the manufacturer, in order to maintain reliable seal performance.

4. Mechanical seals for all services other than chemicals and corrosives shall be equipped with nonclogging, single coil springs and nonsliding, internal, secondary elastomers. Metal parts shall be Type 316 stainless steel, Alloy 20, or Hastelloy B or C.

5. A seal water flush system shall be provided for flushing mechanical seals. The CONCTRACTOR is responsible for coordinating and furnishing and installing a system, complete and self-contained to the pump, with connections to the mechanical seal housing, including an isolation valve and other appurtenances as indicated in the Drawings.

N. Pump appurtenances

1. Nameplates: Each pump shall be equipped with a stainless steel nameplate indicating serial numbers, rated head and flow, impeller size, pump speed, and manufacturer's name and model number.

2. Solenoid Valves: The pump manufacturer shall provide solenoid valves on the water or oil lubrication lines and on all cooling water lines. Solenoid valve electrical ratings shall be compatible with the motor control voltage.

3. Gages:

    a. All pumps (except sample pumps, sump pumps, and hot water circulating pumps) shall be equipped with pressure gages installed at pump discharge lines. Pump suction lines shall be provided with compound gages. Gages shall be located in a representative location, where not subject to shock or vibrations, in order to achieve true and accurate readings.
    b. Where subject to shock or vibrations, the gages shall be wall-mounted or attached to galvanized channel floor stands and connected by means of flexible connectors.
    c. Pressure and compound gages shall be provided in accordance with Section 13400 - Common Work Results Process Instrumentation and Controls.

2.4 VIBRATION AND TEMPERATURE MONITORING SYSTEM

A. General: The vibration and temperature monitoring system shall consist of RTD's and vibration switches, and a remote PLC. The purpose of the vibration and temperature monitoring system is to provide an indication of trouble conditions while the pump is in operation and to shutdown the pump if temperature and vibration exceed setpoints to be defined by pump manufacturer. The protection system components shall be housed in an enclosure in accordance with Section 11103 -Vertical Turbine Pumps.

B. A vibration and temperature protection system shall be provided for pump systems with motors equal to or greater than 250 hp.

C. Vibration switches and RTD Locations: A vibration and temperature monitoring system shall be provided for the pump system as specified herein and as shown on the drawings. Permanently mounted vibration switches with a solid state crystal accelerometer shall be installed on or as close to the upper motor bearing for vertical pumps or the bearing closest to the motor in other applications. Two vibration switches shall be installed per pump, mounted on perpendicular axes to vibration. Vibration switches shall be mounted in accordance with the manufacturer's recommendations. The vibration switch shall be radially mounted as close to the bearing as physically possible. Temperature RTD's; 3 wire 100 OHM Platinum conforming to International Standard IEC-751, shall be installed on each motor winding. All signals from RTD's and Vibration switch shall connect to the plant control system.

D. The accuracy of the vibration switches shall be equal to or greater than plus or minus 10 percent of indicated output that shall be specified by the pump manufacturer. Functional, temperature range is to be from -20 degrees F to 140 degrees F. Vibration switches shall have two solid state trips, one for alarm and one for pump shutdown. Input power for the switches is to be 120 V DC 60 hz.

E. The vibration switches shall be PMC/BETA 440 or 450, Bentley Nevada, or equal.

2.5 MOTORS

A. Unless otherwise indicated in the individual pump sections, each pump shall be provided with a Series 400 stainless steel vertical, solid shaft; high efficiency, high thrust, TEFC enclosure, 460 volt, 3-phase, 60 Hertz heavy duty, electric motor in accordance with Section 16220 – Low Voltage Motors.

B. Variable speed drives shall be provided as specified in each pump section and in accordance with Section 16260 - Low Voltage Adjustable Speed Drive Motor Controllers. The variable frequency drive controller and components shall be housed as specified in each pump Section. Pump Supplier shall coordinate with VFD Supplier to ensure pump and VFD compatibility.

2.6 SPARE PARTS

A. Spare parts shall be provided as indicated in the individual pump sections.

B. The pumps shall be backed by supplies of spare parts from stock, and after-sales service from a factory trained and authorize maintenance facility, located within [500] miles from the installation.

C. All spare parts shall be accompanied by a packing list and be in a condition acceptable to the ENGINEER or his designated representative. The packing list shall include a detailed listing of each item, including name of equipment, referenced Specification Section and subsection, name of part, manufacturer's name, and cost of item. All spare parts shall be delivered and stored as indicated in Section 11000 – Pumps, General

2.7 PROTECTIVE COATING

A. General: Materials and equipment shall be coated in accordance with Section 09900 – Paints and Coatings and the Contract Documents.

B. Shop Coating. After shop testing and before shipment, all ferrous surfaces, excluding machined surfaces and nameplates, shall be shop painted.

C. Field Coating. Field coating shall not be executed until after field testing is completed. Additionally, machined surfaces and nameplates shall not be painted. Color shall be approved by ENGINEER.

2.8 MANUFACTURERS

A. Manufacturer Experience: Manufacturers shall have had previous experience in such manufacture and shall, upon request of the ENGINEER, furnish the names of not less than 5 successful installations of its equipment of comparable nature to that offered under this contract. All manufactured items provided under this Section shall be new, or current manufacture, and shall be the products of reputable manufactures specializing in the manufacture of such products. The Manufacturer’s Qualifications covered in this Section shall be submitted to the ENGINEER.

B. Unit Responsibility: A single manufacturer shall be made responsible for furnishing the Work and for coordination of design, assembly, testing, and installation of the Work of each pump Section; however, the CONTRACTOR shall be responsible to the OWNER for compliance with the requirements of each pump Section. Unless otherwise indicated, the single manufacturer shall be the manufacturer of the pump. Where two or more pump systems of the same type or size are required, the pumps shall all be produced by the same manufacturer.

PART 3 EXECUTION

3.1 DELIVERY AND STORAGE

A. A complete set of manufacturer’s instructions covering storage, installation, operation, lubrication, and maintenance shall be furnished to the OWNER no later than the date the equipment is shipped. Care during storage and procedures for installation, lubrication, and startup of the equipment and motors shall be in strict conformance with the manufacturer’s instructions.

B. The CONTRACTOR shall prepare and load all material and articles for shipment in a manner that protects the equipment and coatings from damage in transit, shall include a packing list, and shall be responsible for and make good any and all damage. During shipping the rotating elements shall be suitably supported or disassembled to protect bearings.

C. Equipment furnished shall be shipped to the site in enclosed, weather-tight, sealed containers in a manner designed to protect the pumping units against damaging stress

caused by sudden acceleration or deceleration. For equipment 25 horsepowers or greater, two recording accelerometers, designed to record the magnitude of any sudden impact in all three directions (X, Y, Z) on continuous strip charts, shall be shipped with, and fixed to each assembly or its packing container. Upon arrival of each shipment, the accelerometers shall be removed in the presence of representatives of the ENGINEER, the CONTRACTOR, and the equipment manufacturer. If magnitude of the maximum acceleration exceeds 3.0 times the acceleration due to the force of gravity (3.0 g), the assembly or subassembly shall be dismantled and completely inspected. All damage shall be corrected to the complete satisfaction of the ENGINEER before the assembly is incorporated in to the work. The CONTRACTOR shall bear all costs arising out of dismantling, inspection, repair, and reassembly.

D. Where necessary, heavy parts or machines shall be mounted on skids or shall be crated, and any articles or materials that might otherwise be lost shall be boxed or wired in bundles and plainly marked for identification. The gross weight shall be clearly marked on all boxes or skidded equipment packages exceeding 200 pounds. All parts exceeding 200 pounds gross weight shall be prepared for shipment so that slings for handling by a crane may be readily attached while the parts are on the car or transport truck. Boxed parts, where it is unsafe to attach slings to the box, shall be packed with slings attached to the part, the slings to project through the box or crate so that attachment to the hoisting equipment can be readily made.

E. All accessories and spare parts shall be packed separately in containers plainly marked “ACCESSORIES ONLY” or “SPARE PARTS ONLY.” All packing materials shall be fire retardant. A packing list, listing the contents of each container, shall be placed in a moisture proof envelope and securely fastened to the outside of the container.

F. All parts shall be properly lubricated and protected so that no damage or deterioration will occur even during a prolonged delay from the time of shipment until installation is completed and the pumps are ready for operation.

G. Finished ferrous surfaces not painted shall be properly protected to prevent rust and corrosion.

H. The finished surfaces of all exposed flanges shall be protected by strong wooden blind flanges.

I. Each pump shall be properly crated to protect the units against damage during shipment.

3.2 INSTALLATION

A. Install in accordance with the manufacturer's printed instructions.

B. Alignment: All equipment shall be field tested to verify proper alignment, operation as specified, and freedom from binding, scraping, vibration, shaft runout, or other defects. Pump drive shafts shall be measured just prior to assembly to ensure correct alignment without forcing. Equipment shall be secure in position and neat in appearance. Pump Alignment to be performed by CONTRACTOR.

C. Lubricants: The CONTRACTOR shall provide the necessary oil and grease for initial operation for a period of at least one year.

D. The CONTRACTOR shall accomplish pump installation with assistance from the pump Manufacturer.

3.3 TESTING

A. General: Provide testing in accordance with Section 01660 Testing and Training.

B. Factory Testing

1. The CONTRACTOR shall be responsible for all costs associated with inspection and testing of materials, products, or equipment at the place of manufacture, unless specified otherwise.

2. The following tests shall be conducted on each indicated pump system:

a. Motors: All motors of sizes 100 hp and larger shall be assembled, tested, and certified at the motor factory and the working clearances checked to insure that all parts are properly fitted. The tests shall be in accordance with ANSI/IEEE 112 - Test Procedure for Polyphase Induction Motors and Generators, and ANSI/IEEE 115 - Test Procedure for Synchronous Machines, including heat run and efficiency tests. All computations shall be recorded and certified and dated copies of the test results shall be furnished .

b. Pump Systems: All pump systems shall be tested at the pump factory in accordance with the American National Standard for Centrifugal Pump Tests (ANSI/HI 1.6) or the American National Standard for Vertical Pump Tests (ANSI/HI 2.6) as approved by ANSI and published by the Hydraulic Institute. Tests shall be performed using the complete pump system to be furnished, including the motor. For motors smaller than 100 hp, the manufacturer's certified test motor shall be acceptable. Testing of prototype models will not be acceptable. The following minimum test data shall be submitted:

1) Hydrostatic test data.
2) A minimum of five hydraulic test readings between shutoff head and 25 percent beyond the maximum indicated capacity, recorded on data sheets as defined by the Hydraulic Institute.
3) Pump curves showing head, flow, bhp, efficiency, and NPSH requirements.
4) Certification that the pump horsepower demand did not exceed the rated motor hp beyond the 1.0 service rating at any point on the curve.

c. Factory Witnessed Tests: All pumps and motors 125 hp and larger shall be factory-tested as complete assembled systems and may be witnessed by the OWNER and ENGINEER. The CONTRACTOR shall give the ENGINEER a minimum of 2 weeks notification prior to the test. At least 2 weeks prior to the test, CONTRACTOR shall submit for review and approval a copy of the proposed test procedure. All costs for OWNER and ENGINEER shall be borne by the OWNER. Test results shall be submitted to the ENGINEER and no equipment shall be shipped until the test data have been approved by the ENGINEER.

d. Acceptance: In the event of failure of any pump to meet any of the requirements, the CONTRACTOR shall make all necessary modifications, repairs, or replacements to conform to the requirements of the Contract

Documents and the pump shall be re-tested at no additional cost to the OWNER until found satisfactory.

C. Installation Functional Testing

1. The CONTRACTOR shall bear all costs of the functional tests, including related services of the manufacturer's representative, except for power and water which the OWNER will bear. If available, the OWNER'S operating personnel will provide assistance in functional testing. All equipment and instrumentation required for the testing shall be provided by the CONTRACTOR.

2. The final adjustments and inspections shall be made by factory-trained and authorized service personnel other than sales representatives, who also shall supervise the installation and test operation. CONTRACTOR shall include in bid, allowance for factory-trained service personnel to adjust all of the said equipment to be installed by CONTRACTOR until this equipment has been tested by the CONTRACTOR and the results of these tests are satisfactory to the ENGINEER or his designated representative.

3. Functional testing will be witnessed by the ENGINEER. The CONTRACTOR shall give notice to the OWNER/ ENGINEER two weeks prior to the scheduled functional field test date.

4. At least 2 weeks prior to the test, CONTRACTOR shall submit for review and approval a copy of the proposed functional test procedure.

5. The following functional testing shall be conducted:

   a. Electrical and instrumentation tests shall conform to the requirements of the Sections under which that equipment is specified.
   b. The pumping station shall operate as described under the control strategy outlined in the instrumentation specification.
   c. A field functional acceptance test shall be made of the entire pumping system, including instruments, controls, alarms, plant control system, control strategy, motors, new pumps, VFDs, existing pumps, and valves, to ensure compliance with the performance specified herein.

6. In the event any pumping system fails to meet the test requirements, it shall be modified and retested as above until it satisfies the requirements.

7. After each pumping system has satisfied the requirements, the CONTRACTOR and Factory Representative shall certify in writing that it has been satisfactorily tested and that all final adjustments have been made. Certification shall include the date of the tests, a listing of all persons present during the tests, and the test data.

D. Operation Performance Testing

1. Where required by the individual pump sections, each pump system shall be performance tested, after installation to demonstrate satisfactory operation without excessive noise, vibration, cavitation, or overheating of bearings. The performance of each pump, motor, and VFD shall be verified.

2. All expenses for conducting the performance testing shall be paid by the CONTRACTOR. All equipment and instrumentation required for the testing shall be provided by the CONTRACTOR.

3. The final adjustments and inspections shall be made by factory-trained and authorized service personnel other than sales representatives, who also shall supervise the installation and test operation. CONTRACTOR shall include in bid, allowance for factory-trained service personnel to adjust all of the said equipment to be installed by CONTRACTOR until this equipment has been tested by the CONTRACTOR and the results of these tests are satisfactory to the ENGINEER or his designated representative.

4. Performance testing will be witnessed by the ENGINEER. The CONTRACTOR shall give notice to the OWNER/ENGINEER 2 (two) prior to the scheduled test date.

5. At least 2 weeks prior to performance test, CONTRACTOR shall submit for review and approval a copy of the proposed performance test procedure.

6. The following performance testing shall be conducted:

   a. Startup, check, and operate the pump system over its entire speed range. Vibration shall be within the amplitude limits recommended by the Hydraulic Institute Standards at a minimum of four pumping conditions defined by the ENGINEER.
   b. Obtain concurrent readings of motor voltage, amperage, pump suction head, and pump discharge head for at least four pumping conditions at each pump rotational speed. Check each power lead to the motor for proper current balance.
   c. Determine bearing temperatures by contact type thermometer. A run time of at least 20 minutes shall precede this test, unless insufficient liquid volume is available.

7. The tests shall demonstrate that the equipment has been properly installed, aligned and connected, is free of mechanical defects, electrical defects, excessive vibration, overheating or overloading, and that the control system performs as specified and meets all operating criteria. All parts shall operate satisfactorily in all respects and in accordance with the specified requirements for the full duration of the test period. If any part of a unit shows evidence of unsatisfactory or improper operation during the test period, correction or repairs shall be made by the CONTRACTOR and the full performance test shall be redone for that unit after all parts operate satisfactorily.

8. After each pumping system has satisfied the requirements, the CONTRACTOR shall certify in writing that it has been satisfactorily tested and that all final adjustments have been made. Certification shall include the date of the tests, a listing of all persons present during the tests, and the test data.

E. Operational Testing

1. Provide testing in accordance with Section 01660 Testing and Training.

END OF SECTION

SECTION 11145 – PROGRESSING CAVITY PUMPS

PART 1 GENERAL

1.1 THE REQUIREMENT

A. The CONTRACTOR shall provide Progressing Cavity Pumps with electric motors, drives, associated piping, controls, wiring and appurtenances, complete and operable, in accordance with the Contract Documents. The pumps shall be manufactured by Netzsch. No other pump manufacturer will be considered.

B. The requirements of Section 11100, Pumps, General, apply to this Section.

C. The MANUFACTURER shall examine the site conditions, intended application, and operation of the pump system and recommend the pump which will best satisfy the indicated requirements.

1.2 REFERENCE SPECIFICATIONS, CODES, AND STANDARDS

A. In addition to the Codes and Standards listed below and except as otherwise indicated, the current editions of the Codes and Standards listed in Section 11100, Pumps General apply to the work of this Section.

1. AGMA 6010-E Standard for Spur, Helical, Herringbone, and Bevel Enclosed Drives

2. AGMA 6019-E Gear Motors Using Spur, Helical, Herringbone, Straight Bevel, or Spiral Bevel Gears

3. ANSI American National Standards Institute, Inc.

1.3 CONTRACTOR SUBMITTALS

A. General: CONTRACTOR shall submit administrative, shop drawings, samples, quality control, and contract closeout submittals of all equipment furnished this Section and in referenced Sections.

B. Shop Drawings and Samples: Shop drawings and samples shall be submitted in accordance with the requirements of Section 01340 Shop Drawings, Product Data and Samples.

1. The CONTRACTOR shall submit a detailed drawing of the pump which indicates the clearances required for pump disassembly. The drawing shall indicate that the pumps meet the requirements of the Contract Documents.

C. O & M Manuals: The CONTRACTOR shall provide operators and maintenance data for all equipment furnished for the project in accordance with Section 01730, Operation and Maintenance Data.

D. Tools: Special tools necessary for maintenance and repair of the equipment shall be furnished as a part of the WORK hereunder; such tools shall be suitably stored in metal

tool boxes, and identified with the equipment number by means of stainless steel or solid plastic name tags attached to the box.

1.4 QUALITY ASSURANCE

A. CONTRACTOR shall submit the following:

1. MANUFACTURER's Certificate of Proper Installation

2. Functional Test Certification

3. Factory performance test reports

4. Special shipping, storage and protection, and handling instructions

5. MANUFACTURER's printed installation instructions

6. List of suggested spare parts to maintain the equipment in service for a period of 5 years. Include a list of special tools required for checking, testing, parts replacement, and maintenance.

7. List of special tools, materials, and supplies furnished with equipment for use prior to and during startup.

B. Warranty

1. A written suppliers warranty shall be provided for the equipment specified in this section as required in Section 11.2, General Conditions.

1.5 MANUFACTURERS SERVICE REPRESENTATIVE

A. Manufacturer's Representative. In accordance with the requirements of Section 01660, a Manufacturer's Representative shall be present at the site or classroom designated by the OWNER to provide the services and minimum person-days listed below, travel time excluded.

1. 1 person-days for installation assistance and inspection,

2. 1 person-days for functional and performance testing

3. 1 person-days for pre-startup training of OWNER's personnel.

PART 2 PRODUCTS

2.1 GENERAL

A. Refer to the Supplemental Pump Data Sheets, attached to this Specification, for specific pump requirements.

2.2 PROGESSIVE CAVITY PUMPS

A. Pump Suction and Discharge Casing

1. The pump casing shall be designed for the type of service specified and shall be of sufficient strength, weight, and metal thickness to ensure long life, accurate

alignment, and reliable operation. The suction casing shall be constructed of close-grained cast iron and have two clean out ports. Stamped or formed metal is not acceptable.

2. The casing shall have connections for vents, drains, and gauges. A min of 3 connections to allow for rotation of housing as needed.

3. The suction and discharge connections shall be ANSI/B16.1 flanges sized for the pump specified. The discharge flange shall have a vent/gauge connection that can be rotated in 90 increments. The discharge support feet shall be separate from the discharge flange.

4. The pump shall be supplied with adequate NPT connections for stuffing box drainage, pump drainage, flushing, and gauge connections.

5. The drain port shall be at the lowest point in the housing to ensure it completely drains regardless of the orientation of the housing.

6. Provide 2 square hand-hole side plates on each side of the pump, 180° apart, large enough to permit easy inspection of the drive shaft joint and mechanical seal and servicing of the pump.

7. There shall be a top inspection cover integral to the design to allow for inspection of rotor joint and clean out of the suction body. The body shall maintain and contain remaining pump components and structural integrity of the pump. Split casings are not acceptable.

8. Pump suction housing shall have a minimum of two support feet to support potential pipe stress and ensure proper reassembly during maintenance.

B. Stator

1. The pump's stator shall be formed from a single piece Buna-n rubber. Split stators or stators that are pieced together are not acceptable due to the potential leakage.

2. The stator housing shall be a two-piece extruded aluminum shell. By removing the shell it shall significantly remove the normal compressive forces to allow easy removal of the stator rubber from the rotor.

3. The stator rubber shall be independent of the metal casing so it can be properly disposed without the metal shell.

4. The stator rubber shall be made with injection cores down the length to ensure proper filling and density (durometer) of the rubber. This will allow proper and even compress across the entire stator and ensure there are no knit lines causing a potential leak where the rubber comes together.

5. The stator rubber shall be made and blended by the pump manufacture specifically designed for PC pumps. Rubber not made and blended by the manufacturer shall not be accepted. In addition, the pump manufacturer shall mold/inject the stators in-house. Stators made by vendors or outsourced are not acceptable.

6. The stator shall be affixed to the suction casing by the use of four (4) thru-bolts for easy removal and replacement. The threaded rods shall exceed the length of the stator. Stators shall not be affixed to the suction casing by threaded connections, by snap rings, or stator side walls. The suction edge of the stator shall be chamfered to allow for unrestricted flow into the pumping elements.

7. The sealing ends shall be integral to the stator sleeve at the suction and discharge to prevent leakage. The use of separate O-rings or flat rings for stator sealing shall not be allowed.

8. Stator designs that limit nominal pump pressure capability to less than 90 PSI shall not be acceptable.

9. The removal of the rotor and stator (together as one assembly) shall not require any disconnection of the suction or discharge piping. Pump shall be full service in place. Deviations or special adaptors are not allowed.

10. Stator removal from the pump shall not require any special tools or small pieces that could be lost.

C. Rotor

1. The rotor shall be precision machined from tool steel with a chromium content of 11-13.5% hardened to a Rockwell C hardness of C57-60 and then covered with heavy layers of hard chrome plating.

2. The removal of the rotor shall not require any disconnection of the suction or discharge piping. Pump shall be full service in place. Deviations or special adaptors are not allowed

3. Rotor rotation shall be counter-clockwise, to the left if looking from the drive end.

4. The rotor shall be longer than the stator when assembled to ensure maximum usage and complete sealing line of the stator from both ends. Rotors shorter or that does not extend out the end of the stator when assembled are not acceptable.

5. The removal of the rotor shall not require any disconnection of the suction or discharge piping. Deviations or special adaptors are not allowed. The disconnection of the rotor shall be as easy by the removal of a single bolt. Multiple bolts, snap rings, sleeves, clips, wedges, or disconnection of the joint are not acceptable.

6. Removal of the stator shall include the rotor joint for complete inspection and

7. Access to rotor disconnection area shall have a minimum of 2” of accessibility from all angles to allow for easy servicing.

D. Universal Joint

1. The rotor shall be connected to the drive shaft by means of a connecting rod with high strength, shock resistant universal joints. The universal joints shall be a sealed Pin type, lubricated by oil. Gear joints are not acceptable.

2. The sealed pin-type universal joints shall be factory lubricated with oil and completely sealed from the abrasive fluid being pumps.

E. Drive Train

1. The rotor shall be driven by means of a heavy duty sealed drivetrain. The rotor shall be joined to the drive shaft by means of a connecting rod with sealed pin-type universal joints at each end.

2. The connecting rod shall be two-piece design to allow for the rotor and stator to be removed from the suction housing. Disassembly of a joint is not acceptable.

3. The connecting rod shall be joined and driven by hardening pins. Using screws or bolts to transfer rotational thrust is not acceptable.

4. The sealed pin-type universal joints shall be factory lubricated with oil and completely sealed from the abrasive fluid being pumps, utilizing a metal cover over the pin and flexible rubber seal on the connecting rod end.

5. The joint seal shall not employ sacrificial parts such as clamp bands and shall not require special tools to assemble.

6. To optimize seal and pin joint life, the connecting rod shall be of sufficient length to maintain its operating angle within 1 degree. Flexishafts, Cardin joints, gear joints, and unsealed pin joints are not acceptable.

F. Shaft seal

1. The pumps shall be fitted with a single mechanical seal with Silicon Carbide Seal faces and 316 stainless steel metal parts. The mechanical seal shall be a rubber bellows seal.

2. The mechanical seal shall be inside mounted, located inside the pump suction housing with ample open area around the seal and not in a dead-end enclosed housing where solids could accumulate.

G. Pump Drive Shaft

1. The drive shaft shall be of the solid drive shaft design in order to avoid clogging and/or trapping of solids, which could either interrupt the movement of the connecting rod or disturb the seal of the rear joint. Maximum shaft deflection under normal operating conditions shall not exceed 0.002”. Hollow or telescoping designed drive shafts are not acceptable.

2. The universal joint head shall be removable from the drive shaft to allow access to the stuffing box or mechanical seal without disturbing the drive end of the pump.

3. The drive shaft shall be connected to a flanged gear reducer by a pin in a close coupled design to reduce the space needed for a coupling.

H. Performance requirements

1. Refer to the Supplemental Pump Data Sheets, attached to this Specification, for specific pump requirements.

2. The suction body of the pump shall be oversized at the entrance of the rotor and stator pumping elements to allow the free flow of high solids materials. The rotor joint head shall be set back from the stator and the leading edge of the stator shall be chamfered so not to restrict the flow into the pumping elements. If the pump does not incorporate the aforementioned features, the use of a rag deflector shall be required.

I. Controls

1. Pump controls shall be supplied per the requirements of the applicable Sections of Division 13 and Section 11100 Pumps, General.

J. Motor

1. Shall be as required in the Supplemental Pump Data Sheet in accordance with Section 16220 Low Voltage Motors.

2. Motor shall be TEFC, Premium Efficient with class F insulation, 1.15 service factor. Motor must be Inverter Duty, suitable for a constant torque turndown ratio as recommended by the Manufacturer.

3. Each drive assembly shall be provided with a drive controller that adjusts the output speed of the drive motor. The drive controller shall be a variable frequency drive unit complying with the requirements specified in Section 16260, Low Voltage Variable Frequency Motor Controllers.

K. Gear Reducer Features

1. The gear reducer shall be parallel in-line helical reducer with a 1.4 service factor. The gear case is to be single piece SAE 30 gray cast iron with internal reinforcements for strength rigidity. This design eliminates oil leakage, oil contamination, and gear set misalignment problems common to drives with bolt-on output cover or flanges.

L. Spare parts

1. One stator

2. One rotor

3. One connecting rod

4. One set connecting rod joint assembly

5. One set of mechanical seals

6. Two sets of drive pins, washers, and screws

7. Two sets of packings or seals, gaskets, and o-rings

M. Protective Coating

1. Materials and equipment shall be coated in accordance with Section 09900 Painting and Coatings and the Contract Documents.

N. Manufacturers

1. MANUFACTURER Experience shall be in accordance with Section 11100, Pumps, General.

2. Unit Responsibility

a. Unit Responsibility shall be in accordance with Section 11100, Pumps, General.
b. The manufacturer of the pump shall have unit responsibility and shall furnish the complete motor, pump, and VFD system. All VFD systems provided under the contract shall be of a single manufacturer. See Section 16260, Low Voltage Variable Frequency Motor Controllers.
c. Unit responsibility for the VFDs in this section shall also be as specified in Section 11000. The Contractor shall submit letters of certification with the shop drawings from the VFD manufacturer, the motor manufacturer, and the driven equipment manufacturer stating that they have reviewed each application and that the combination will satisfy the application duties required, for the actual motor sizes required, regardless of deviations from the scheduled "nominal horsepower."
d. Where a pump or package process system supplier is responsible for supplying the pump, motor and VFD as required in Division 11 or Division 13, the supplier shall coordinate the VFD and motor and provide certification that the driven equipment, motor, and VFD are compatible and will meet the system requirements of the application. Certification from the supplier shall state that they have reviewed application requirements and that the equipment, motor, and VFD combination will satisfy the application duties required, incorporating any deviations from the nominal horsepowers shown on the Contract Documents.

3. Manufacturers, No Equal:

a. Netzsch

PART 3 EXECUTION

3.1 GENERAL

A. Execution shall be in accordance with Section 11100, Pumps General.

3.2 DELIVERY AND STORAGE

A. A complete set of MANUFACTURER's instructions covering storage, installation, operation, lubrication, and maintenance shall be furnished to the OWNER no later than the date the equipment is shipped. Care during storage and procedures for installation, lubrication, and startup of the equipment and motors shall be in strict conformance with the MANUFACTURER's instructions.

3.3 INSTALLATION

A. Install in accordance with the MANUFACTURER's printed instructions.

3.4 TESTING

A. Testing shall be in accordance with Section 11100, Pumps, General

3.5 SUPPLEMENTS

A. The supplements listed below, following “END OF SECTION,” are part of this Specification.

1. Scum Pump Data Sheet

END OF SECTION

PUMP DATA SHEET
PROGRESSIVE CAVITY PUMPS
PUMPS NO.: 36-P-01-S, 36-P-02-S

Project	Wastewater Treatment Plant Expansion – Phase II	Mfr's Name	
OWNER	City of Brentwood	A. Netzsch	
Service:	Secondary Scum		
Pump Name:	Secondary Scum Pump No. 3, Secondary Scum Pump No. 4		
Eqpt. Tag Nos.	36-P-01-S, 36-P-02-S	**No Equal**	
Quantity	Two (2)		

Operating Conditions		**Service Conditions**	
Liquid Temperature °F	Normal: 68 Max: 85 Min: 50	Ambient Temperature °F	Normal: 70 Max: 85 Min: 50
Specific Gravity	1.0 at 60 °F	Altitude (ft)	55
Vapor Pressure (psia)		Environment	Indoors, damp, corrosive
Viscosity at 25 °C	0.85 centistokes	Relative Humidity	Max: 100, Min 20
pH	6 - 8	Duty	Intermittent

Performance Requirements			
	Design Point 1	Design Point 2	Design Point 3
Design Flow Capacity (gpm), Normal	40		
Design Pump Head, TDH (ft)	42		
Efficiency (%)			
Minimum NPSH Available (ft)	32		
Maximum Pump Speed (rpm)	245		

Pump Construction Details			
	Size, inch	Rating, psi	Location
Min Suction	3	125	Vertical
Min Discharge	3	125	Horizontal
Seal Type	Double Mechanical		
No. Stages:	1		

Motor Data			
Motor Horsepower	3	Voltage	480
Speed (rpm)	1,800	Phase	3
Enclosure Type:	TEFC	Service Factor @ rated max amb. Temp)	1.20
Mounting Type	Base Plate		
Drive Type	Direct Drive		
MANUFACTURER: For multiple units of same type of equipment, furnish motors and accessories of a single MANUFACTURER			
No	Hazardous Location: Furnish motors for hazardous (classified) locations that conform to UL 674 or have an applied UL listing mark		

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SECTION 11148 – SUBMERSIBLE NON-CLOG

PART 1 GENERAL

1.1 THE REQUIREMENT

A. The CONTRACTOR shall provide submersible non-clog pumps and motors with associated piping, controls, wiring, and appurtenances, including guide bars, cast iron discharge base elbow, lifting cables, connection brackets, nameplates and access covers, complete and operable, in accordance with the Contract Documents. Pumps shall be complete and operable, in accordance with the requirements of this specification.

B. The requirements of Section 11100 – Pumps, General, apply to this Section.

C. The Supplier shall examine the site conditions, intended application, and operation of the pump system and recommend the pump which will satisfy the indicated requirements.

D. All submersible non-clog pumping equipment shall be provided by the same pump and motor manufacturers.

1.2 REFERENCE SPECIFICATIONS, CODES, AND STANDARDS

ASTM A53 Grade B	Specification for Pipe, Steel, Black and Hot Dipped, Zinc-Coated, Welded and Seamless
ASTM B584	Specification for Copper Alloy Sand Castings for General Applications.
ANSI/AWWA C200	Standards for Steel Water Pipe 6 in. and Larger
ANSI/AWWA C208	Standards for Dimension for Fabricating Steel Water Pipe Fittings
ANSI/API 610	Centrifugal Pumps for General Refinery Service
NFPA 820	Fire Protection in Wastewater Treatment and Collection Facilities

1.3 CONTRACTOR SUBMITTALS

A. General: CONTRACTOR shall submit administrative, shop drawings, samples, quality control, and contract closeout submittals of all equipment furnished this Section and in referenced Sections.

B. Shop Drawings and Samples: Shop drawings and samples shall be submitted in accordance with the requirements of Section 01340 Shop Drawings, Product Data and Samples.

C. O & M Manuals: The CONTRACTOR shall provide operators and maintenance data for all equipment furnished for the project in accordance with Section 01730, Operation and Maintenance Data.

D. Tools: Special tools necessary for maintenance and repair of the equipment shall be furnished as a part of the WORK hereunder; such tools shall be suitably stored in metal tool boxes, and identified with the equipment number by means of stainless steel or solid plastic name tags attached to the box.

1.4 QUALITY ASSURANCE

A. CONTRACTOR shall submit the following:

1. MANUFACTURER's Certificate of Proper Installation

2. Functional Test Certification

3. Factory performance test reports

4. Special shipping, storage and protection, and handling instructions

5. MANUFACTURER's printed installation instructions

6. List of suggested spare parts to maintain the equipment in service for a period of 5 years. Include a list of special tools required for checking, testing, parts replacement, and maintenance.

7. List of special tools, materials, and supplies furnished with equipment for use prior to and during startup.

B. Warranty

1. A written suppliers warranty shall be provided for the equipment specified in this section as required in Section 11.2, General Conditions.

1.5 MANUFACTURERS SERVICE REPRESENTATIVE

A. Manufacturer's Representative. In accordance with the requirements of Section 01660, a Manufacturer's Representative shall be present at the site or classroom designated by the OWNER to provide the services and minimum person-days listed below, travel time excluded.

1. 1 person-days for installation assistance and inspection,

2. 1 person-days for functional and performance testing

3. 0.5 person-days for pre-startup training of OWNER's personnel.

PART 2 PRODUCTS

2.1 GENERAL

A. All submersible non-clog pumps, motors and drives shall be designed for wastewater pumping applications.

B. Each pump shall be capable of continuous operation at full load, without cavitation or overheating of the motor, with a minimum operating water level as designated on the contract drawings or as outlined in the control strategies for each pump system.

C. Each pump, with its motor, cable and appurtenances, shall be able to withstand continuous submergence to a minimum depth of 65 feet, when running or off, without leakage.

D. Cooling System: Pumps with motors up to 10-hp: Motors are sufficiently convection-cooled by the surrounding environment or pumped media. A water jacket is not required.

2.2 PERFORMANCE REQUIREMENTS

A. Each pump shall be able to operate for short periods at zero static suction head without causing any damage to any part of the unit.

B. Refer to the Supplemental Pump Data Sheets, attached to this Specification, for specific pump requirements.

2.3 PUMP

A. Impeller: The Impeller(s) shall be of gray cast iron, Class 35B, dynamically balanced, multiple vaned, double shrouded non-clogging design having long throughlets with acute turns. The Impeller(s) shall be capable of handling solids, fibrous materialsand other matter found in wastewater.

B. Pump and Motor shaft shall be a solid continuous shaft. The pump shaft is an extension of the motor shaft. Couplings shall not be acceptable. The shaft shall be stainless steel – ASTM A479 S43100-T. The use of stainless steel sleeves will not be considered equal to stainless steel shafts as shaft sleeves only protect the shaft around the lower mechanical seal.

C. Bearings: Permanently lubricated, heavy-duty axial and radial ball or roller bearings, top and bottom, double shielded with a minimum L-10 life of 100,000 hours, at continuous, maximum load and speed, supported by detailed calculations, to be submitted with the shop drawings.

D. Seals: Independent double mechanical shaft seals, easily replaceable, oil lubricated, with moisture detector probes, alarm, and test circuits. The seals shall not require any maintenance or adjustment, nor any differential pressure to affect sealing. Material shall be corrosion resistant double tungsten-carbide with stainless steel springs.

E. Pump, volute, oil casing, sliding: Material shall be cast iron, ASTM A-48 bracket, motor frame.

F. Exposed bolts, nuts, washers: Material shall be Type 316 stainless steel.

G. Wear rings

1. Volute wear ring: A wear ring system shall be used to provide efficient sealing between the volute and suction inlet of the impeller. Each pump shall be equipped with a Nitrile rubber coated steel or brass ring insert.

2. Impeller wear ring: The pump shall have a stainless steel impeller wear ring.

H. Oil Chamber: Each pump shall be fitted with an oil chamber that acts as a barrier between the pumped fluid and motor. The oil chamber shall have accessibility from the exterior of the pump and shall be filled with environmentally safe Glycol based oil. A moisture sensor probe must be installed in the oil chamber to detect moisture. A corresponding relay, located in the pump control panel, shall be used in conjunction with the seal probe to detect moisture.

I. Suction can(s) shall be provided by the pump manufacturer at no additional costs to the City or CONTRACTOR.

2.4 CONTROLS

1. Pump controls shall be supplied per the requirements of the applicable Sections of Division 13 and Section 11100 Pumps, General.

2.5 MOTOR:

A. Shall be as required in the Supplemental Pump Data Sheet in accordance with Section 16220 Low Voltage Motors.

B. Motor: The pump motor shall be a completely sealed, electric submersible, squirrel-cage induction, shell type design, housed in an air filled watertight chamber, NEMA B type. The motor shall have a 1.15 service factor and be rated for 480 volts, 3 phase, 60 Hz. The motor shall be designed for continuous duty, capable of sustaining a minimum of 10 starts per hour. The temperature rise of the motor shall not be in excess of that specified in NEMA Standard MG1 for Class B insulating materials when operating continuously under load. The stator should be heat shrink fitted into the stator housing in order to transport heat losses most effective. The use of bolts, set screws, pins, or other fastening devices requiring penetration of the stator housing shall be rejected.

1. The pump motor shall be a NEMA B design, induction type with a squirrel cage rotor, shell type design, housed in an air filled, watertight chamber. The stator windings shall be insulated with moisture resistant Class H insulation rated for 180°C (356°F). The stator shall be insulated by the trickle impregnation method using Class H monomer-free polyester resin resulting in a winding fill factor of at least 95%. The stator shall be heat-shrink fitted into the cast iron stator housing. The use of multiple step dip and bake-type stator insulation process is not acceptable.

2. The motor horsepower shall not be less than the maximum pump horsepower specified for each pump and the actual horsepower shall be adequate throughout the entire range of the published curve without overloading.

3. The motors shall be designed, manufactured, and tested in accordance with the requirements and recommendations for NEMA MG 1. The motors shall comply with the latest ANSI, NEMA, and IEEE standards, and the National Electrical Code. All electrical characteristics shall be rated at 40 degrees C.

4. Motors shall be properly sized and completely compatible with the drive system supplied.

5. The motor shall include the following design and construction features to assure AFD compatibility:

    a. Avoid loose windings-use slot fillers as required.
    b. Insulate between phases-both end turns and in slots.
    c. Secure end turns-tie or band both winding ends.
    d. Avoid loose windings, use slot fillers as required.
    e. Insulate between phases, both end turns and in slots.
    f. Secure end turns, tie or band both winding ends.
    g. Provide VPI treatment.

6. Be especially careful to avoid damaging winding magnet wire. Provide a larger frame size motor for the specified horsepower if necessary to provide the aforementioned features.

7. Motors shall be adjustable speed where noted in the Supplemental Pump Data Sheet (suitable to be controlled by an adjustable speed drive, as described in NEMA MG 1, 1.32, and Part 30) and shall comply with the requirements specified in Section 16260, Low Voltage Variable Frequency Motor Controllers.

C. Power Cable:

1. Each pump shall be furnished with the necessary cables for power connection, moisture detection, and overload protection, sheathed, coded, and suitable for submersible non-clog pumps. All cables shall be connected to the pumps and tested at the factory.

2. Separate power and control cables shall be adequately shielded to prevent any interference if cables are installed as shown on the contract drawings.

3. The power and control cable shall be in accordance with all applicable electrical specifications in the contract documents.

4. Power cable shall be sized according to NEC standards and shall be supplied in lengths as required for proper installation. The motor and cable shall be capable of continuous submergence under water without loss of watertight integrity to a depth of 65 feet.

5. Include necessary cables for power connection, moisture detection, and overload protection, sheathed, coded, and suitable for submersible non-clog pumps, and of sufficient length for direct connection to field panel. Wicking fillers will not be accepted. Power cables shall keep separate from cable or cables for thermal protection and moisture detection or shall be adequately shielded to prevent interference.

6. If the cable entry is not leakproof when cable is cut below water level, the junction chamber containing the terminal board shall be hermetically sealed from the motor by elastometer compression seal (0-ring). Connection between the cable conductors and stator leads shall be made with threaded compressed type binding post permanently affixed to a terminal board.

D. PUMP/MOTOR PROTECTION

1. Pump/Motor protection for the pumps in this section shall be provided at no additional costs.

2. All stators shall incorporate thermal switches in series to monitor the temperature of each phase winding. The thermal switches shall open at 125 degree C (260 degree F), stop the motor and activate an alarm.

3. A leakage sensor shall be available as an option to detect water in the stator chamber.

4. The dry contacts shall change status upon occurrence of an over temperature of leakage condition so as to indicate that condition to other control components in the pump control panel.

5. In the case of an over temperature, the over temperature dry contacts shall be used to trip the pump offline.

6. Nameplates: Provide a nameplate for each motor. As a minimum, the motor nameplate shall meet the requirements of NEMA MG1, Part 20.

2.6 GUIDE BARS, BRACKETS AND FITTINGS

A. Support bracket and discharge elbow: Cast duckfoot bend or discharge elbow with machined face, anchored to sump floor.

1. Pumps shall be provided with discharge elbows for permanent installation in the wet well. The pump shall be designed with a centerline discharge. Where required, adapters shall be provided to match the pump to the discharge elbow. Sealing of the pumping unit to the discharge connection shall be accomplished by a machined metal to metal watertight contact. Sealing of the discharge interface with a diaphragm, O-ring or profile gasket will not be acceptable. Pumps shall be easily removable for inspection or service, requiring no bolts, nuts or other fastenings to be removed for the purpose and no need for personnel to enter the tank/wet well. Sealing of the pumping unit to the discharge elbow shall be accomplished by a simple linear downward motion of the pumps with the entire weight of the pumping units guided to and pressed tightly against the discharge elbow with a watertight contact. No portion of the pump shall bear directly on the floor of the sump. Guide bars, which shall steer the pump into proper contact with the discharge elbow, shall be non-adjustable and shall not bear the weight of the pump.

2. Connections: Machined metal-to-metal quick disconnect type, for withdrawal of unit from above, without disconnecting pipe. When lowered into place, the pump shall automatically connect and lock into the discharge pipe without touching the floor.

B. Guide bars:

1. Two guide bars shall be provided by the Pump Manufacturer with each pump for raising and lowering the pumping units. The guide bars or cables shall not support any portion of the weight of the pump. All components of the guide system including actual guide bars or cables shall be provided under this specification. The lower guide holders shall be integral with the discharge elbow. The upper guide bracket shall be furnished to support and align the bars/cables at the top of

the wet well. Connection to the top slab/ access cover shall be coordinated by the CONTRACTOR.

2. The pump unit shall be guided on the bars by a guide bracket which shall be an integral part of the pump.

3. Guide bars shall be of the diameter and length recommended by the pump manufacturer for proper installation. Guide Bars shall be suitable for guiding new pumps.

4. Guide Bars, Upper guide brackets and safety hooks shall be fabricated from Type 316 stainless steel.

C. Lifting chain and fittings: Each pump shall be fitted with up to 50 feet of Type 316 stainless steel lifting chain capable of lifting the pump and motor. The necessary fittings and the lifting cable holder shall be Type 316 stainless steel. Lifting cable holder shall be attached to the top slab, accessible from the hatch opening. Connection to the top slab/ access cover shall be coordinated by the CONTRACTOR.

2.7 SPARE PARTS

A. The requirements of Section 11100 Pumps, General, apply to this Section.

B. The following spare parts shall be furnished as a minimum:

1. (1) set of wearing rings, complete with fasteners

2. (3) sets of O-rings

3. (1) set lower mechanical seal

4. (1) set of bearings

5. (1) submersible cable of required length with termination kit (for each size pump)

6. (1) impeller (trimmed, balanced, statically, dynamically) (for each size pump)

7. (1) set of special tools as required for pumping unit disassembly (for all pumps)

C. No additional compensation shall be provided for provision of the items cited above.

2.8 PROTECTIVE COATING

A. Manufacturer to provide prime coat of Standard Heavy Duty Paint System suitable for the working environment of the pump.

B. Materials and equipment shall be coated in accordance with Section 09900 Painting and Coatings and the Contract Documents.

2.9 MANUFACTURERS

1. MANUFACTURER’s Experience: The materials and equipment covered by this specification are intended to be standard materials and equipment of demonstrated successful performance and supplied by a manufacturer who has

been actively engaged in the supply of 1,000 similarly sized submersible non-clog wastewater pumps installed and operating for no less than 5 years in the United States. Equipment shall be designed and constructed in accordance with the highest standards of the industry and shall be installed in accordance with the MANUFACTURER's recommendations and the Contract Documents.

2. Unit Responsibility

   a. Unit Responsibility shall be in accordance with Section 11100, Pumps, General.
   b. The manufacturer of the pump shall have unit responsibility and shall furnish the complete motor, pump, and VFD system. All VFD systems provided under the contract shall be of a single manufacturer. See Section 16260, Low Voltage Variable Frequency Motor Controllers.
   c. Unit responsibility for the VFDs in this section shall also be as specified in Section 11000. The Contractor shall submit letters of certification with the shop drawings from the VFD manufacturer, the motor manufacturer, and the driven equipment manufacturer stating that they have reviewed each application and that the combination will satisfy the application duties required, for the actual motor sizes required, regardless of deviations from the scheduled "nominal horsepower."
   d. Where a pump or package process system supplier is responsible for supplying the pump, motor and VFD as required in Division 11 or Division 13, the supplier shall coordinate the VFD and motor and provide certification that the driven equipment, motor, and VFD are compatible and will meet the system requirements of the application. Certification from the supplier shall state that they have reviewed application requirements and that the equipment, motor, and VFD combination will satisfy the application duties required, incorporating any deviations from the nominal horsepowers shown on the Contract Documents.

3. Manufacturer, No Equal (match existing):

   a. Flygt N-series

PART 3 EXECUTION

3.1 DELIVERY AND STORAGE

A. A complete set of MANUFACTURER's instructions covering storage, installation, operation, lubrication, and maintenance shall be furnished to the OWNER no later than the date the equipment is shipped. Care during storage and procedures for installation, lubrication, and startup of the equipment and motors shall be in strict conformance with the MANUFACTURER's instructions. The requirements of Section 11100 Pumps, General apply to this section.

3.2 INSTALLATION

A. Install in accordance with the MANUFACTURER's printed instructions. The requirements of Section 11100 Pumps, General apply to this section.

3.3 TESTING

A. General: In addition to the requirements listed in Section 11100 Pumps, General, all submersible non-clog pumps shall be factory, functional and performance tested as listed below.

B. Factory Testing

1. Testing should be to Hydraulic Institute Level A Standards.

2. In addition to the requirements in Section 11100 Pumps, General, each pump shall be tested for performance at the factory to determine head versus capacity, efficiencies, and kilowatt draw required for the operational points indicated in the data sheets. All tests shall be run in accordance with the American Hydraulic Institute Standards. Testing shall also include the following:

   a. Impeller, motor rating, and electrical connections shall first be checked for compliance with the Contract Documents.
   b. A motor and cable insulation test for moisture content or insulation defects shall be made.
   c. Prior to submergence, the pump shall be run dry to establish correct rotation and mechanical integrity.
   d. The pump shall be run for 30 minutes submerged, a minimum of 6 feet under water, at 1/4, 1/2, 3/4, and full flow, without cavitation or overheating.
   e. After operational test described below, the insulation test described above shall be performed again.
   f. A written report stating the tests have successfully been completed and providing the results of the test shall be furnished for each pump.
   g. Verification of cavitation-free service and absence of motor overheating during conditions simulating the actual operating conditions after installation at a water level equivalent to the invert of the influent sewer of the pump station.
   h. Pump seals shall be designed for complete water tightness at 65 feet submergence for 30 minutes and data on factory testing and quality control shall be submitted with the shop drawings.

C. Functional Testing

1. The requirements of Section 11100 Pumps, General, apply to this section.

D. Performance Testing

1. The requirements of Section 11100 Pumps, General, apply to this section.

E. Operational Testing

1. The requirements of Section 11100 Pumps, General, apply to this section.

3.4 SUPPLEMENTS

A. The supplements listed below, following “END OF SECTION,” are part of this Specification.

1. RAS Pump Station Sump Pumps Data Sheet

2. Filter Feed Pumps Data Sheet

END OF SECTION

PUMP DATA SHEET
SUBMERSIBLE NON-CLOG PUMPS
PUMPS NO.: 36-P-01-PD, 36-P-02-PD

Project	Wastewater Treatment Plant Expansion – Phase II	Mfr's Name	
OWNER	City of Brentwood	A. Flygt	
Service:	Plant Drainage		
Pump Name:	RAS Pump Station Sump Pump No. 3, RAS Pump Station Sump Pump No. 4		
Eqpt. Tag Nos.	36-P-01-PD, 36-P-02-PD	**No Equal**	
Quantity	Two (2)		

Operating Conditions		**Service Conditions**	
Liquid Temperature °F	Normal: 68 Max: 80 Min: 50	Ambient Temperature °F	Normal: 70 Max: 85 Min: 50
Specific Gravity	1.0 at 60 °F	Altitude (ft)	55
Vapor Pressure (psia)		Environment	Indoors, damp, corrosive
Viscosity at 25 °C	0.85 centistokes	Relative Humidity	Max: 100, Min 20
pH	6 - 8	Duty	Intermittent

Performance Requirements				
	Design Point 1 – Design Flow at Full Speed			
Design Flow Capacity (gpm), Normal	50			
Design Pump Head, TDH (ft)	57			
Min Efficiency (%)	40			
Minimum NPSH Available (ft)	32			
Maximum Pump Speed (rpm)	1800			

Pump Construction Details			
	Size, inch	Rating, psi	Location
Min. Suction	4	150	--
Min. Discharge	4	150	Horizontal
Seal Type	Double independent mechanical		

Motor Data			
Motor Horsepower	10	Voltage	480
Speed (rpm)	1,800	Phase	3
Enclosure Type:	Submersible	Service Factor @ rated max amb. Temp)	1.15
Mounting Type	Direct		
Drive Type	Constant Speed		
MANUFACTURER: For multiple units of same type of equipment, furnish motors and accessories of a single MANUFACTURER			
No	Hazardous Location: Furnish motors for hazardous (classified) locations that conform to UL 674 or have an applied UL listing mark		

PUMP DATA SHEET
SUBMERSIBLE NON-CLOG PUMPS
PUMP NO. 61-P-03-SE

Project	Wastewater Treatment Plant Expansion – Phase II	Mfr's Name	
Owner	City of Brentwood	A. Flygt	
Service:	Secondary Effluent	B.	
Pump Name:	Filter Feed Pump No. 3	C.	
Eqpt. Tag Nos.	61-P-03-SE	**No Equal**	
Quantity	One (1)		

Operating Conditions		**Service Conditions**	
Liquid Temperature °F	Normal: Max: Min:	Ambient Temperature °F	Normal: Max: Min:
Specific Gravity	1.0 at 6.5°F	Altitude (ft)	Sea Level
Vapor Pressure(psia)	14.4	Environment	Filter Feed Wet Well
Viscosity at 25 °C		Relative Humidity	100%
pH	7	Duty	Continuous

Performance Requirements			
	Design Point 1 – 1 Pump – Design Flow	Design Point 2 – 1 Pump – Minimum Flow	Design Point 3 – 4 Pumps – Future Maximum Flow
Design Flow Capacity (gpm), Normal	4200	1040	1013
Design Pump Head, TDH (ft)	21	16.4	24
Min Efficiency (%)	80	80	80
Minimum NPSH Available (ft)	32	32	32
Maximum Pump Speed (rpm)	900	900	900

Pump Construction Details			
	Size, inch	Rating, psi	Location
Suction	14	150	--
Discharge	14	150	Horizontal
Seal Type	Double independent mechanical		

Motor Data			
Motor Horsepower	40 hp	Voltage	480 V
Speed (rpm)	1800	Phase	3
Enclosure Type:	Submersible	Service Factor @ rated max amb. Temp)	1.15
Mounting Type	Direct		
Drive Type	VFD		
Manufacturer: For multiple units of same type of equipment, furnish motors and accessories of a single manufacturer			
No	Hazardous Location: Furnish motors for hazardous (classified) locations that conform to UL 674 or have an applied UL listing mark		

SECTION 11149 – SUBMERSIBLE SUMP PUMP

PART 1 GENERAL

1.1 THE REQUIREMENT

A. The CONTRACTOR shall provide submersible stainless steel sump pumps with associated wiring, and appurtenances, in accordance with the Contract Documents. Pumps shall be complete and operable, in accordance with the requirements of this specification.

B. The requirements of Section 11100 – Pumps, General, apply to this Section.

C. The Supplier shall examine the site conditions, intended application, and operation of the pump system and recommend the pump which will satisfy the indicated requirements.

D. All submersible sump pumps shall be provided by the same pump and motor manufacturers.

1.2 CONTRACTOR SUBMITTALS

A. General: CONTRACTOR shall submit administrative, shop drawings, samples, quality control, and contract closeout submittals of all equipment furnished this Section and in referenced Sections.

B. Shop Drawings and Samples: Shop drawings and samples shall be submitted in accordance with the requirements of Section 01340 Shop Drawings, Product Data and Samples.

C. O & M Manuals: The CONTRACTOR shall provide operators and maintenance data for all equipment furnished for the project in accordance with Section 01730, Operation and Maintenance Data.

1.3 QUALITY ASSURANCE

A. CONTRACTOR shall submit the following:

1. Special shipping, storage and protection, and handling instructions

2. MANUFACTURER's printed installation instructions

3. List of suggested spare parts to maintain the equipment in service for a period of 5 years. Include a list of special tools required for checking, testing, parts replacement, and maintenance.

4. List of special tools, materials, and supplies furnished with equipment for use prior to and during startup.

B. Warranty

1. A written suppliers warranty shall be provided for the equipment specified in this section as required in Section 11.2, General Conditions.

2. Submersible sump pumps shall be warranties to be free of defects for at least twelve months from the date of installation or eighteen (18) months from the date of shipment, whichever comes first.

PART 2 PRODUCTS

2.1 GENERAL

A. All submersible sump pumps, motors and drives shall be designed to pump water containing 3/8” spherical solids.

B. Each pump shall be capable of continuous operation at full load, without cavitation or overheating of the motor, with a minimum operating water level as designated on the contract drawings or as outlined in the control strategies for each pump system.

C. Each pump, with its motor, cable and appurtenances, shall be able to withstand continuous submergence, when running or off, without leakage.

2.2 PERFORMANCE REQUIREMENTS

A. Each pump shall be able to operate either fully or partially submerged.

B. Refer to the Supplemental Pump Data Sheets, attached to this Specification, for specific pump requirements.

2.3 PUMP

A. Impeller: The Impeller(s) shall be 304L stainless steel, and semi-open.

B. Shaft: The pump shaft shall be 303 stainless steel.

C. Bearings: Semi-sealed ball bearings shall be provided.

D. Seals: The pumps shall be furnished with a single mechanical seal (lower side) and a single lip seal (upper side). Mechanical seal shall be FPM and lip seal shall be NBR.

E. Casing, motor frame and fasteners: Material shall be 304 stainless steel. A handle shall be provided on the pump casing.

2.4 CONTROLS

1. Pump controls shall be supplied per the requirements of the applicable Sections of Division 13 and Section 11100 Pumps, General.

2.5 MOTOR:

A. Motor: The pump motor shall be a completely sealed, electric submersible, split capacitor design, housed in an air filled with Class F insulation watertight chamber. The motor shall have a 1.15 service factor and be rated for 115 volts, single phase, 60 Hz. The motor shall be designed for continuous duty, up to 20 starts per hours. The motor shall have a built-in thermal protection with automatic reset.

B. Power Cable:

1. Each pump shall be furnished with the necessary cables for power connection, sheathed, coded, and suitable for submersible pump applications. All cables shall be connected to the pumps and tested at the factory.

2. Cables shall be UL/CSA approved water resistant #16 AWG cord and shall be supplied in lengths as required for proper installation.

3. The power and control cable shall be in accordance with all applicable electrical specifications in the contract documents.

2.6 MANUFACTURERS

a. EBARA, EPD Model 3MS1, No Equal (match existing)

PART 3 EXECUTION

3.1 DELIVERY AND STORAGE

A. A complete set of MANUFACTURER's instructions covering storage, installation, operation, lubrication, and maintenance shall be furnished to the OWNER no later than the date the equipment is shipped. Care during storage and procedures for installation, lubrication, and startup of the equipment and motors shall be in strict conformance with the MANUFACTURER's instructions. The requirements of Section 11100 Pumps, General apply to this section.

3.2 INSTALLATION

A. Install in accordance with the MANUFACTURER's printed instructions. The requirements of Section 11100 Pumps, General apply to this section.

3.3 SUPPLEMENTS

A. The supplements listed below, following "END OF SECTION," are part of this Specification.

1. Sample Pumps Data Sheet

END OF SECTION

PUMP DATA SHEET
SUBMERSIBLE SUMP PUMPS
PUMPS NO.: 62-P-06-SA, 62-P-07-SA, 62-P-08-SA

Project	Wastewater Treatment Plant Expansion – Phase II	Mfr's Name	
OWNER	City of Brentwood	A. EBARA	
Service:	Sample		
Pump Name:	Sample Pump		
Eqpt. Tag Nos.	62-P-06-SA, 62-P-07-SA, 62-P-08-SA	**No Equal**	
Quantity	Three (3)		

Operating Conditions		**Service Conditions**	
Liquid Temperature °F	Normal: 68 Max: 80 Min: 50	Ambient Temperature °F	Normal: 70 Max: 85 Min: 50
Specific Gravity	1.0 at 60 °F	Altitude (ft)	Sea level
Vapor Pressure (psia)		Environment	Submersible
Viscosity at 25 °C	0.85 centistokes	Relative Humidity	100%
pH	6 - 8	Duty	Intermittent

Performance Requirements				
	Design Point 1			
Design Flow Capacity (gpm), Normal	15			
Design Pump Head, TDH (ft)	22			
Maximum Pump Speed (rpm)	3600			

Pump Construction Details			
	Size, inch	Rating, psi	Location
Min. Suction	-	150	--
Min. Discharge	1-1/4	150	Vertical
Seal Type	Oil lubricated mechanical seal		

Motor Data			
Motor Horsepower	1/3 hp	Voltage	115
Speed (rpm)	3,600	Phase	1
Enclosure Type:	Submersible	Service Factor @ rated max amb. Temp)	1.15
Mounting Type	Direct		
Drive Type	Constant Speed		
MANUFACTURER: For multiple units of same type of equipment, furnish motors and accessories of a single MANUFACTURER			
No	Hazardous Location: Furnish motors for hazardous (classified) locations that conform to UL 674 or have an applied UL listing mark		

SECTION 11150 – SUBMERSIBLE PROPELLER PUMPS

PART 1 GENERAL

1.1 THE REQUIREMENT

A. The CONTRACTOR shall furnish all labor, materials, tools and equipment necessary for complete installation of submersible propeller pumps for Mixed Liquor Recycle pumping in the biological reactors as shown on the drawings and specified herein.

B. The CONTRACTOR shall furnish and install all submersible propeller pumps complete with submersible power cable, guide rail system, hoist base, lifting cable, power cable, support cable, controls and all appurtenant equipment, complete and operable, in accordance with the requirements of the Contract Documents.

C. The system shown on the Drawings is based on the supply of the first-named Supplier, Manufacturer, or Vendor. The Drawings show a general depiction of the equipment and indicate a level of accessibility and clearances that shall be required for installation and maintenance of the system components. The specific location of system connections and equipment may vary depending on the System Supplier. Additionally, the quantity and methods used for meeting the Contract requirements for safety may differ between what is provided by the System Suppliers and what is shown on the Contract Drawings. The supplied system shall fit within the footprints shown on the Drawings while maintaining the level of accessibility and clearances shown on the Drawings. If the Contractor selects a System Suppler other than the first-named System Supplier, Contractor shall be responsible for the cost of all modifications required to provide the accessibility and clearance requirements, and modifications required of equipment that are tailored to the specific system design at no additional cost to the Owner. Such changes to the layout shall not impair the equipment accessibility or limit maintenance access as generally indicated on the Drawings, nor shall it relieve the System Supplier's responsibility for meeting the requirements of the Contract Documents. Any re-design of structures, foundations, support utilities, or any other related infrastructure needed to accommodate other than the first-named supplier shall be borne by the Contractor, without additional cost to the Owner; any such re-design of related infrastructure shall be by the Owner's design engineer. Any costs associated with the Owner's design engineer evaluation of Contractor proposed alternate System Suppliers shall be borne by the Contractor.

D. The requirements of Section 11100 – Pumps, General, apply to this section

E. Related Sections:

1. Section 01340 – Shop drawings, Product Data, and Samples
2. Section 01660 – Testing and Training
3. Section 01730, Operation and Maintenance Data
4. Section 05500 - Metal Fabrications
5. Section 09900 – Painting and Coatings.
6. Section 11100 – Pumps, General

7. Section 11205 – Submersible Compact Mixer

8. Section 13400 – Common Work Results Process Instrumentation and Controls

9. Section 14600 – Hoists, Cranes, and Winches

10. Section 15200 - Valves.

11. Section 16220 – Low Voltage Motors.

1.2 REFERENCE SPECIFICATIONS, CODES, AND STANDARDS

A. Except as otherwise indicated, the current editions of the Specifications and Standards listed in Section 11100 - Pumps General and the following apply to the work of this Section:

ASTM A 48	Standard Specification for Gray Iron Castings
ASTM A 53	Pipe, Steel, Black and Hot-Dipped Zinc Coated, Welded and Seamless
ASTM A 283	Low and Intermediate Tensile Strength Carbon Steel Plates

1.3 CONTRACTOR SUBMITTALS

A. General: CONTRACTOR shall submit administrative, shop drawings, samples, quality control, and contract closeout submittals of all equipment furnished this Section and in referenced Sections in accordance with the requirements of Section 01340 Shop Drawings, Product Data and Samples.

B. Shop Drawings and Samples: In addition to the requirements of Section 01340 Shop Drawings, Product Data and Samples, CONTRACTOR shall submit the following:

1. Submersible propeller pump

   a. Name of manufacturer
   b. Type and Model
   c. Rotational speed
   d. Major component materials of construction

2. Propeller pump specification describing construction details

3. Outline dimension drawing

4. Installation drawing

5. Complete performance data showing capacity and power input

6. Electrical data that includes:

   a. Motor rating, hp
   b. Motor temperature rating
   c. Motor full load rotational speed
   d. Motor full load current
   e. Motor locked rotor current

f. Power cable data
g. Motor performance curves showing speed, efficiency, current, power, etc.
h. Moisture sensor protection characteristics and wiring diagram

7. Propeller Pump Mast Assembly

a. Mast assembly specifications
b. Mast assembly details and materials of construction

C. O & M Manuals: The CONTRACTOR shall provide operations and maintenance data for all equipment furnished for the project in accordance with Section 01730, Operation and Maintenance Data.

D. Tools: Special tools necessary for maintenance and repair of the equipment shall be furnished as a part of the WORK hereunder; such tools shall be suitably stored in metal tool boxes, and identified with the equipment number by means of stainless steel or solid plastic name tags attached to the box.

1.4 QUALITY ASSURANCE:

A. CONTRACTOR shall submit the following:

1. MANUFACTURER's Certificate of Proper Installation

2. Functional Test Certification

3. Factory performance test reports

4. Special shipping, storage and protection, and handling instructions

5. MANUFACTURER's printed installation instructions

6. List of suggested spare parts to maintain the equipment in service for a period of 5 years. Include a list of special tools required for checking, testing, parts replacement, and maintenance.

7. List of special tools, materials, and supplies furnished with equipment for use prior to and during startup.

B. Warranty

1. A written suppliers warranty shall be provided for the equipment specified in this section as required in accordance with the General Conditions.

1.5 MANUFACTURERS SERVICE REPRESENTATIVE

A. In accordance with the requirements of Section 01660 – Testing and Training, a MANUFACTURER's Representative shall be present at the site or classroom designated by the OWNER to provide the services and minimum person-days listed below, travel time excluded.

1. One (1), eight-hour (8-hr.) days for each unit for installation assistance and final installation inspection

2. One (1), eight-hour (8-hr.) days for each unit for functional and performance testing

3. One (1), eight-hour (8-hr.) days for each unit a factory representative, who has complete knowledge of proper operation and maintenance shall be provided to instruct representatives of the OWNER and ENGINEER on proper operation and maintenance, including pre-startup, start-up and shut-down procedures, proper lubrication practices, and troubleshooting of all equipment.

4. If there are difficulties in operation of the equipment due to the Manufacturer's fabrication or Contractor's installation, additional service shall be provided at no extra cost to the Owner.

PART 2 PRODUCTS

2.1 GENERAL:

Number of Propeller Pumps	2 duty per each OD; 1 duty per each AB; 1 shelf spare (7 total)
Location	OD and AB Oxic Zones 1-H, Per Drawings
Equipment Tag Numbers	Per Drawings
Liquid Pumped	Mixed Liquor Activated Sludge
Design Liquid Suspended Solids Concentration Range (mg/l.)	3,000 to 6,000
Duty	Continuous
Maximum Liquid Depth (ft)	13.6

2.2 SUBMERSIBLE PROPELLER PUMPS

A. General

1. Type: Each propeller pump shall be submersible with the motor close-coupled, directly connected to the propeller. Gear box designs shall not be acceptable. The propeller shall be capable of handling solids, fibrous materials, heavy sludge, and other matter found in wastewater applications.

2. Submergence: All components of the propeller pump, including motor, shall be capable of continuous underwater operation in both of the following conditions: (1) propeller pump blade completely submerged, and (2) propeller pump blade partly submerged in an unbalanced hydraulic loading condition. In addition, all components of the propeller pump, including motor, shall be capable of continuous operation in air, completely un-submerged, for 2 hours minimum.

3. Mounting: The propeller pumps shall be designed to be easily raised, lowered, and removed for inspection or service, without the need for personnel to enter the

tank. A sliding guide bracket shall be an integral part of each propeller pump. The guide bracket shall guide the propeller pump into position and be capable of carrying the entire weight of the propeller pump and the maximum loads created by the propeller pump. The propeller pump, with its appurtenances and power cable, shall be capable of continuous submergence under water without loss of watertight integrity to a depth of 130 ft.

4. Mating Surface Seals: All mating surfaces where watertight sealing is required shall be machined and be fitted with a double set of nitrile rubber or Viton O-rings.

5. Propeller: The propeller shall be non-clogging backward curved design, capable of handling solids, fibrous materials, heavy sludges, and other matter normal found in wastewater treatment applications. Propeller shall be dynamically balanced so the propeller imbalance does not exceed ISO 1940 G6.3 tolerances to prevent excessive vibrations. The propeller shall have two or three vanes and be of the diameter and of the blade angle, in degrees, as indicated. Each blade shall be laser cut and welded to the hub to ensure that the propeller is properly balanced.

6. Bearings: The shaft shall rotate on two or three permanently lubricated bearings. The outboard propeller end bearing shall be an angular contact or deep grove bearing. The inboard, motor end, bearings shall be an angular contact or deep grove to take up the axial loads and a radial bearing to take up the radial loads. The bearings shall be pre-loaded, if needed, by a bearing loading nut located on the motor end of the shaft in order to reduce shaft deflection and increase bearing and seal life. All bearings shall have a minimum L-10 rated life of 100,000 hours.

7. Shaft: The propeller and motor shaft shall be an integral unit. The shaft shall be designed to meet the maximum loads generated by the propeller pump. The propeller pump shafts shall have machined shoulders to permit exact bearing, seal and propeller placement. Torque shall be transmitted to the propeller by a keyed shaft arrangement.

8. Shaft Seals:

    a. Each propeller pump shall be provided with two sets of lapped end face type mechanical seals or an outside lapped end fact type mechanical seal and inner lip seal running in an oil chamber for cooling and lubrication. Shaft seals without positively driven rotating members shall not be accepted. Only the seal faces of the outer seal assembly shall be exposed to the mixed media.

    b. Each propeller pump shall be provided with an oil chamber for the shaft sealing system. The oil chamber shall be designed for oil pressure compensation. The drain and inspection plugs, with positive anti-leak seal, shall be easily accessible from the outside.

    c. The mechanical seal shall require neither maintenance nor adjustment, shall not be damaged when the propeller pump is run dry, shall be easy to check and replace, shall be capable of running in either direction without damage, and be readily available from any major seal manufacturer. Shaft seals that rely on the tank fluid as a lubricant will not be considered acceptable or equal.

9. Shroud (if necessary): Each propeller pump assembly shall be provided with a shroud a full 360 degrees around the propeller. A maximum clearance of 1-1/2 inch shall be maintained between the propeller tip and the shroud. The shroud shall be designed so that it connects to the pipe mounted connection with guide rails. The shroud and the pipe flange mounted discharge connection shall be of Type 316 stainless steel.

B. Performance Requirements:

Minimum Pumping Capacity (gpm)	2,400
Design TDH (ft)	1.7
Maximum Propeller Speed (rpm)	860
Drive Type	Direct
Minimum Horsepower Rating (hp)	5
Voltage, Phase, Hertz	480, 3, 60
Maximum Full Load Current (amp)	6.7
Minimum Motor Efficiency at Full Load (percent)	40
Discharge Flange Diameter	16”

C. Materials of Construction

1. Mixer components in contact with the liquid shall be of Type 316 stainless steel with smooth surfaces devoid of blow holes and other irregularities. All exposed nuts, bolts, fasteners, and hardware shall be of Type 316 stainless steel.

2. The propeller shall be of Type 316 stainless steel.

3. The propeller shaft shall be of Type 316, Type 420, or Type 431 stainless steel.

4. The mechanical seals shall contain a stationary face ring of silicon carbide and be a rotating face ring of silicon carbide.

5. The plug-in mechanical seal assembly shall contain positively driven rotary, corrosion resistant, Tungsten Carbide/Tungsten Carbide seal face rings for both the inner and outer seals. One face of the inner seal ring pair shall have spiral grooves laser etched in it, to provide a pumping action to move leakage from the stator housing back into the oil chamber. In order to avoid seal failure due to sticking, clogging, and misalignment from elements contained in the mixed media, only the seal faces of the outer seal assembly and its retaining clips shall be exposed to the mixed media. All other components shall be contained in the oil housing.

6. The pump shall be equipped with a seal shield that prevents fibrous material from winding up around the shaft and outer seal. The shield shall be welded to the propeller hub and extend towards the motor. The shield shall rotate with the

propeller and there shall be a radial micro-gap between the shield and oil-housing.

7. All anchor bolts, nuts, and washers shall be Type 316 stainless steel.

D. Controls

1. Pump control and instrumentation components shall be supplied per Section 13400 Common Work Results Process Instrumentation and Controls.

2. Each motor shall be provided with temperature and moisture protection system meeting the requirements below:

a. Provide each motor with integral solid-state temperature sensors, one in each phase.

b. Each mixer shall be equipped with an electrical probe to detect the presence of moisture before bearing and motor damage occurs.

c. Control conductors for the sensors shall be integral with the motor power cable.

d. Sensors shall be wired to a control and status relay unit.

1) The control and status relay unit shall have the following maintained dry contact outputs rated no less than 4 amps and 12-volt, 60-Hz:

OVERTEMP (OPEN on over temperature)
OVERTEMP indicated (CLOSED on over temperature)
MOISTURE (OPEN on moisture)
MOISTURE indication (CLOSED on moisture)

e. The control and status relay unit shall be provided by the pump supplier for mounting in the motor control center. The control and status relay shall be connected as indicated on the electrical drawings. Relay unit supply voltage shall be 120VAC.

E. Motor and Power cable

1. General: The requirements of Section 11100 – Pumps General, apply to this section.

2. Motor: The pump motor shall be a completely sealed, electric submersible, squirrel-cage induction, shell type design, housed in an air filled watertight chamber, NEMA B type. The motor shall rated for 460 volts, 3 phase, 60 Hz. The motor shall be designed for continuous duty, capable of sustaining a minimum of 30 starts per hour. The temperature rise of the motor shall not be in excess of that specified in NEMA Standard MG1 for Class H insulating materials when operating continuously under load. The stator should be heat shrink fitted into the stator housing in order to transport heat losses most effective. The use of bolts, set screws, pins, or other fastening devices requiring penetration of the stator housing shall be rejected.

a. The pump motor shall be a NEMA B design, induction type with a squirrel cage rotor, shell type design, housed in an air filled, watertight chamber. The stator windings shall be insulated with moisture resistant Class H insulation rated for 180oC (356oF). The stator shall be insulated by the trickle impregnation method using Class H monomer-free polyester resin resulting in a winding fill factor of at least 95%. The motor shall be inverter duty rated in accordance with NEMA MG1, Part 31.The stator shall be heat-shrink fitted into the cast iron stator housing. The use of multiple step dip and bake-type stator insulation process is not acceptable.

b. The motor horsepower shall not be less than the maximum pump horsepower specified for each pump and the actual horsepower shall be adequate throughout the entire range of the published curve without overloading.

c. The motors shall be designed, manufactured, and tested in accordance with the requirements and recommendations for NEMA MG 1. The motors shall comply with the latest ANSI, NEMA, and IEEE standards, and the National Electrical Code. All electrical characteristics shall be rated at 40 degrees C.

d. Motors shall be properly sized and completely compatible with the drive system supplied.

e. Motors shall be inverter-duty, with insulation systems capable of withstanding a 1,600 volt peak.

f. Motors shall be adjustable speed where noted in the pump schedule (suitable to be controlled by an adjustable speed drive, as described in NEMA MG 1, 1.32, and Part 30).

3. Power Cables

a. Each pump shall be furnished with the necessary cables for power connection, moisture detection, and overload protection, sheathed, coded, and suitable for submersible non-clog pumps. All cables shall be connected to the pumps and tested at the factory.

b. Power cables shall be adequately shielded to prevent any interference if cables are installed as shown on the contract drawings.

c. The power cable shall be in accordance with all applicable electrical specifications in the contract documents.

d. Power cable shall be sized according to NEC standards and shall be supplied in lengths as required for proper installation. The motor and cable shall be capable of continuous submergence under water without loss of watertight integrity to a depth of 65 57 feet. Power cable shall be CSA approved and suitable for use in hazardous locations in accordance with NEC Class 1, Division 1, Group C and D.

e. Include necessary cables for power connection, moisture detection, and overload protection, sheathed, coded, and suitable for submersible non-clog pumps, and of sufficient length for direct connection to field panel. Wicking fillers will not be accepted. Power cables shall keep separate from cable or

cables for thermal protection and moisture detection or shall be adequately shielded shielded from sensor signal conductors to prevent interference with thermal protection and moisture detection devices.

f. If the cable entry is not leakproof when cable is cut below water level, the junction chamber containing the terminal board shall be hermetically sealed from the motor by elastometer compression seal (0-ring). Connection between the cable conductors and stator leads shall be made with threaded compressed type binding post permanently affixed to a terminal board.

F. Mounting and Support System

1. Each propeller pump shall be equipped with a mounting assembly and vertical support mast designed to secure the propeller pump while in operation and guide it during installation and removal without entering or emptying the tank. The vertical support mast shall be supported from the basin floor and the basin walkway as appropriate.

1. The top mast connection to the basin walkway shall be capable of being installed at positions 0-deg, 90-deg, 180-deg, and 270-deg of the installed pump axis such that the connection can be made to a walkway located in front, to the side, or behind the pump.

2. Pipe Flange Mounted Discharge Connection (If Necessary): Each propeller pump shall be provided with a 316 Stainless Steel pipe flange mounted discharge connection as shown on the Contract Drawings.

3. All components of the mounting assembly including propeller pump mounting base plate, pipe flange mounted discharge connection, vertical support mast, sliding bracket, and fastening hardware shall be Type 316 stainless steel.

4. The vertical support mast section shall be a minimum of 2-inch by 2-inch by 3/16 inch if square or 2” diameter schedule 10 if round. The assembly shall be designed and constructed to securely support the propeller pump, including providing adequate thrust resistance under all propeller pump operating conditions, including both submerged and un-submerged operation. The mast shall be provided with a cable holder that prevents the electric cable from being entangled with the propeller pump propeller during operation. The mast shall be constructed to positively lock the mast in place at all operating positions.

5. Power Cable Support: Provide a minimum ¼-inch diameter 316 stainless steel power cable support cable shall be provided with each propeller pump and be permanently attached to the propeller pump shackle on one end and the upper guide bracket of the mounting system on the other end. The power cable shall be attached to the support cable using sway clamps at a minimum of 5 feet intervals.

6. Lifting Cable: Provide a minimum ¼ inch diameter 316 stainless steel lifting cable shall be provided and securely attached to each propeller pump. The top of the cable shall end in an eye of sufficient strength to develop the strength of the cable. Provide a hook to secure the cable at the top of the mast.

G. Accessories

1. Lifting Lugs: Equipment weighing over 100 pounds shall be provided with lifting lugs.

2. Identification Plate: An identification plate shall be securely mounted on the equipment in a readily visible location. The plate shall bear the 1/4 inch die-stamped equipment identification number and equipment data.

3. Anchors: Concrete anchors shall be in conformance with Section 05500, Miscellaneous Metals, minimum 5/8-inch diameter Type 316 stainless steel. Coordinate required size and location with Shop Drawings. The mixer MANUFACTURER shall determine the proper location for anchors.

H. Spare parts:

1. Each size and type of propeller pump shall be supplied with the following parts:

a. Two sets motor shaft bearings.
b. Two sets seals, gaskets, and O-rings.

2. Shelf spares:

a. Provide one (1) shelf spare pump.

I. Protective coating

1. Shop and field painting shall be in accordance with requirements specified in Section 09900, Paints and Coating.

J. Manufacturers

1. MANUFACTURER's Experience: The materials and equipment covered by this specification are intended to be standard materials and equipment of demonstrated successful performance and supplied by a manufactured who has been actively engaged in the supply of similarly sized submersible propeller pumps for a minimum of 5 years. Equipment shall be designed and constructed in accordance with the highest standards of the industry and shall be installed in accordance with the MANUFACTURER's recommendations and the Contract Documents.

2. Unit Responsibility:

a. The submersible propeller pumps and accessories specified herein shall be the design and fabrication of a single MANUFACTURER which shall have the sole source responsibility for the propeller pumps and accessories.

b. Submersible Propeller Pumps shall be of the same MANUFACTURER as the submersible mixers, Specification Section 11205.

c. To ensure the integrity of the mounting system the propeller pump MANUFACTURER shall supply the support guide brackets.

3. Manufacturers or Approved Equal:

a. Flygt Corporation, PP 4600 Series

b. ABS, RCP Series

c. Or Approved Equal

PART 3 EXECUTION

3.1 GENERAL

A. Execution shall be in accordance with Section 11100, Pumps General.

3.2 DELIVERY AND STORAGE

A. A complete set of MANUFACTURER's instructions covering storage, installation, operation, lubrication, and maintenance shall be furnished to the OWNER no later than the date the equipment is shipped. Care during storage and procedures for installation, lubrication, and startup of the equipment and motors shall be in strict conformance with the MANUFACTURER's instructions.

3.3 INSTALLATION

A. Install in accordance with the MANUFACTURER's printed instructions.

3.4 TESTING

A. General

1. Testing shall be in accordance with Section 11100, Pumps, General and Section 11205 - Submersible Compact Mixers.

END OF SECTION

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SECTION 11198 – HORIZONTAL NON-CLOG PUMPS

PART 1 GENERAL

1.1 THE REQUIREMENT

A. The CONTRACTOR shall furnish and install two (2) horizontal non-clog pumps, with electric motors and all appurtenant work, complete and operable, in accordance with the requirements of the Contract Documents. The pumps shall be manufactured by Fairbanks Morse to match existing pumps. No other pump manufacturer will be considered.

B. The requirements of Section 11100, Pumps, General, apply to this Section.

C. The MANUFACTURER shall examine the site conditions, intended application, and operation of the pump system and recommend the pump which will best satisfy the indicated requirements.

1.2 REFERENCE SPECIFICATIONS, CODES, AND STANDARDS

A. Codes. The Electrical Code, as referenced herein, shall be the latest edition of the National Electric Code (NEC).

B. Commercial Standards. All equipment, products, and their installation shall be in accordance with the latest editions of the following standards, as applicable, and as specified in each Section of these Specifications.

1. American Hydraulic Institute (AHI)

2. Anti-Friction Bearing Manufacturers Association (AFBMA)

3. Factory Mutual Engineering Corporation (FM)

4. National Electrical Manufacturers Association (NEMA)

5. Underwriters Laboratory (UL)

C. This Section contains references to the following documents. In case of a conflict between the requirements of this Section and those of the listed document, the requirements of this Section shall prevail. The latest edition of the following reference shall be used:

1. ASTM A48 Gray Iron Castings

1.3 CONTRACTOR SUBMITTALS

A. General: CONTRACTOR shall submit administrative, shop drawings, samples, quality control, and contract closeout submittals of all equipment furnished this Section and in referenced Sections.

B. Shop Drawings and Samples: Shop drawings and samples shall be submitted in accordance with the requirements of Section 01340 Shop Drawings, Product Data and Samples including but not limited to the following:

1. Manufacturers' predicted pump performance curves. The curves shall include a plot of head (feet) vs. flow (gpm), horsepower (BHP), efficiency, and NPSHR. Pump curves shall be provided for full speed, 90 percent, 80 percent, 70 percent, 60 percent speeds, and at other speeds required to meet operating conditions. Include at each operating point, pump and combined pump and motor efficiencies.

2. Dimensional drawings of the pumps. Provide a material specification list describing materials used in the manufacturer of the pump.

3. Anchorage calculations per requirements of Division 1 Specification Sections 11000, and 11100.

4. Specifications for the motor including horsepower, voltage, frequency, phase and NEMA insulation and frame classes. Control drawings and data.

5. Letter that guarantees proper pump operation at all design points.

6. Prior to shipping, submit certified pump curve with hydraulic test data.

7. Submit installation guides prior to installing equipment.

C. O & M Manuals: The CONTRACTOR shall provide operators and maintenance data for all equipment furnished for the project in accordance with Section 01730, Operation and Maintenance Data.

D. Tools: Special tools necessary for maintenance and repair of the equipment shall be furnished as a part of the WORK hereunder; such tools shall be suitably stored in metal tool boxes, and identified with the equipment number by means of stainless steel or solid plastic name tags attached to the box.

1.4 QUALITY ASSURANCE

A. CONTRACTOR shall submit the following:

1. MANUFACTURER's Certificate of Proper Installation

2. Functional Test Certification

3. Factory performance test reports

4. Special shipping, storage and protection, and handling instructions

5. MANUFACTURER's printed installation instructions

6. List of suggested spare parts to maintain the equipment in service for a period of 5 years. Include a list of special tools required for checking, testing, parts replacement, and maintenance.

7. List of special tools, materials, and supplies furnished with equipment for use prior to and during startup.

B. Warranty

1. A written suppliers warranty shall be provided for the equipment specified in this section in accordance with the General Conditions.

C. Equipment provided under this Section shall be end products of one manufacturer in order to achieve standardization for operation, maintenance, spare parts and manufacturer's service.

D. The pumps shall be capable of operating continuously at the specified operating conditions without cavitation or damaging vibration, as tested in accordance with the American Hydraulic Institute standards for testing.

1.5 MANUFACTURERS SERVICE REPRESENTATIVE

A. Manufacturer's Representative. In accordance with the requirements of Section 01660, a Manufacturer's Representative shall be present at the site or classroom designated by the OWNER to provide the services and minimum person-days listed below, travel time excluded.

1. 1 person-days for installation assistance and inspection,

2. 1 person-days for functional and performance testing

3. 1 person-days for pre-startup training of OWNER's personnel.

PART 2 PRODUCTS

2.1 GENERAL

A. Refer to the Supplemental Pump Data Sheets, attached to this Specification, for specific pump requirements.

2.2 HORIZONTAL NON-CLOG PUMPS

A. General

1. Casing

a. The pump casing shall be of the one piece volute type with integral suction and discharge nozzles. The discharge nozzle shall be on the centerline of the casing. It shall be of sufficient strength, weight and thickness to provide accurate alignment and prevent excessive defection.

b. The casing shall be designed to permit the removal of the rotating assembly without disturbing the suction or discharge connections and provided with a handhole to permit inspection and cleaning of the pump interior. The handhole cover shall be bolted and its inner contour shall match the contour of the casing. The casing shall be hydrostatically tested to one and one-quarter times the maximum shut off pressure and provided with vent, drain, and gauge connections.

2. Suction and Backhead: The suction shall be designed to provide equal flow distribution to the impeller eye. It shall be provided with a flanged connection, a handhole with removable cover and a gauge tap connection.

3. Impeller

   a. The impeller shall be single stage, end-suction, non-clog, centrifugal, and shall be designed to minimize clogging and to pass solids, trash, and stringy materials contained in sewage.
   b. The impeller shall be accurately machined and polished to remove hollows or projections which might encourage cavitation. The impeller shall be statically and dynamically balanced.
   c. The impeller shall be secured to the shaft by a silicon bronze locknut and then held in place by a locking screw assembly. The arrangement shall be such that the impeller cannot be loosened by torque from either forward or reverse rotation.

4. Shaft and Coupling: The shaft shall be of sufficient size to transmit the full drive horsepower with a liberal safety factor. Coupling shall be 3-piece adjustable spacer type designed to permit the removal of the rotating assembly without disturbing the motor or the suction or discharge piping.

5. Shaft Sleeve: The shaft shall be protected from wear in the stuffing box. The shaft sleeve shall be sealed to prevent leakage between the sleeve and shaft.

6. Mechanical Seal: The stuffing box shall be cast integrally with the stuffing box head, designed to accommodate a mechanical seal. The stuffing box shall be readily accessible. The pumps shall be equipped with water flushed double mechanical seals.

7. Bearings: Pump bearings shall be ball thrust bearings. The bearings shall be arranged to eliminate all radial play and designed for a minimum B-10 life of 60,000 hours in accordance with AFBMA. The bearings shall be grease lubricated and provided with tapped openings for addition of lubricant and draining. Suitable seals shall be provided in the bearings covers to prevent the entrance of contaminants. All bearings shall be accessible while the pump is in operation.

8. Base: The combination pump and driver base shall be of sufficient size, strength, and rigidity to provide support and prevent excessive vibration. The base shall be constructed of a fabricated steel open channel base with large access openings to facilitate grouting. The base shall also provide for easy access to stuffing box, bearing frame, and coupling for maintenance.

B. Performance requirements

1. Refer to the Supplemental Pump Data Sheets, attached to this Specification, for specific pump requirements.

C. Materials of construction

1. Casing: The casing shall be designed for and furnished with a rigid base of fabricated steel or cast iron. Casing shall be constructed of cast iron ASTM A48, Class 30.

2. Suction and backhead: The suction and backhead shall be of the same material as the casing.

3. Impeller: The impeller shall be constructed of cast iron, ASTM A48, Class 30.

4. Shaft and Coupling: The pump shaft shall be ASTM A108, Grade 1018 steel or better, accurately machined over the entire length.

5. Shaft Sleeve: The sleeve shall be stainless steel containing a minimum of 13 percent chrome.

D. Controls

1. Pump controls shall be supplied per the requirements of the applicable Sections of Division 13 and Section 11100 Pumps, General.

E. Motor:

1. Shall be as required in the Supplemental Pump Data Sheet in accordance with Section 16220 Low Voltage Motors.

2. Each drive assembly shall be provided with a drive controller that adjusts the output speed of the drive motor. The drive controller shall be a variable frequency drive unit complying with the requirements specified in Section 16260, Low Voltage Variable Frequency Motor Controllers.

F. Spare parts

1. One (1) impeller with nut and washer

2. One (1) shaft with sleeve

3. One (1) set of bearings

4. One (1) mechanical seal

5. One (1) set of wear rings

6. One (1) set of gaskets and oil seals

G. Protective Coating

1. Materials and equipment shall be coated in accordance with Section 09900 Painting and Coatings and the Contract Documents.

H. Manufacturers

1. MANUFACTURER's Experience: The materials and equipment covered by this specification are intended to be standard materials and equipment of demonstrated successful performance and supplied by a manufacturer who has been actively engaged in the supply of 1,000 similarly sized horizontal non-clog pumps for a minimum of 5 years. Equipment shall be designed and constructed in accordance with the highest standards of the industry and shall be installed in

accordance with the MANUFACTURER's recommendations and the Contract Documents.

2. Unit Responsibility

   a. Unit Responsibility shall be in accordance with Section 11100, Pumps, General.
   b. The manufacturer of the pump shall have unit responsibility and shall furnish the complete motor, pump, and VFD system. All VFD systems provided under the contract shall be of a single manufacturer. See Section 16260, Low Voltage Variable Frequency Motor Controllers.
   c. Unit responsibility for the VFDs in this section shall also be as specified in Section 11000. The Contractor shall submit letters of certification with the shop drawings from the VFD manufacturer, the motor manufacturer, and the driven equipment manufacturer stating that they have reviewed each application and that the combination will satisfy the application duties required, for the actual motor sizes required, regardless of deviations from the scheduled "nominal horsepower."
   d. Where a pump or package process system supplier is responsible for supplying the pump, motor and VFD as required in Division 11 or Division 13, the supplier shall coordinate the VFD and motor and provide certification that the driven equipment, motor, and VFD are compatible and will meet the system requirements of the application. Certification from the supplier shall state that they have reviewed application requirements and that the equipment, motor, and VFD combination will satisfy the application duties required, incorporating any deviations from the nominal horsepowers shown on the Contract Documents.

3. Manufacturers:

   a. Fairbanks Morse.
   b. Flygt.

PART 3 EXECUTION

3.1 DELIVERY AND STORAGE

A. A complete set of MANUFACTURER's instructions covering storage, installation, operation, lubrication, and maintenance shall be furnished to the OWNER no later than the date the equipment is shipped. Care during storage and procedures for installation, lubrication, and startup of the equipment and motors shall be in strict conformance with the MANUFACTURER's instructions.

3.2 INSTALLATION

A. Install in accordance with the MANUFACTURER's printed instructions.

3.3 TESTING

A. General

B. Factory Testing

C. Functional Testing

D. Performance Testing

1. Performance testing of the full-scale equipment shall be required in accordance with Section 01660 Testing and Adjusting.

3.4 SUPPLEMENTS

A. The supplements listed below, following “END OF SECTION,” are part of this Specification.

1. RAS Pump Data Sheet

END OF SECTION

PUMP DATA SHEET
HORIZONTAL NON-CLOG PUMPS
PUMPS NO.: 36-P-02-RAS, 36-P-03-RAS

Project	Wastewater Treatment Plant Expansion – Phase II	Mfr's Name	
OWNER	City of Brentwood	A. Fairbanks Morse	
Service:	Return activated sludge	B. Flygt	
Pump Name:	RAS Pump No. 5, RAS Pump No. 6		
Eqpt. Tag Nos.	36-P-02-RAS, 36-P-03-RAS	**No Equal (match existing)**	
Quantity	Two (2)		

Operating Conditions		**Service Conditions**	
Liquid Temperature °F	Normal: 68 Max: 80 Min: 50	Ambient Temperature °F	Normal: 70 Max: 85 Min: 50
Specific Gravity	1.0 at 60 °F	Altitude (ft)	55
Vapor Pressure (psia)		Environment	Indoors, damp, corrosive
Viscosity at 25 °C	0.85 centistokes	Relative Humidity	Max: 100, Min 20
pH	6 - 8	Duty	Continuous

Performance Requirements				
	Design Point 1 – 1 Pump – Design Flow at Full Speed	Design Point 2 – 1 Pump – Minimum Flow	Design Point 3 – 2 Pumps – Design Flow at Full Speed	Design Point 4 – 2 Pumps – Average Flow
Design Flow Capacity (gpm), Normal	2430	830	2430	1200
Design Pump Head, TDH (ft)	22	17	27	19
Min Efficiency (%)	78		78	76
Minimum NPSH Available (ft)	32	32	32	32
Maximum Pump Speed (rpm)	720	720	720	720

Pump Construction Details			
	Size, inch	Rating, psi	Location
Min. Suction	8	150	Horizontal
Min. Discharge	8	150	Vertical
Seal Type	Double Mechanical		

Motor Data			
Motor Horsepower	25	Voltage	480
Speed (rpm)	1,800	Phase	3
Enclosure Type:	TEFC	Service Factor @ rated max amb. Temp)	1.15
Mounting Type	Direct Coupled		
Drive Type	VFD		
MANUFACTURER: For multiple units of same type of equipment, furnish motors and accessories of a single MANUFACTURER			
No	Hazardous Location: Furnish motors for hazardous (classified) locations that conform to UL 674 or have an applied UL listing mark		

SECTION 11205 – SUBMERSIBLE COMPACT MIXERS

PART 1 GENERAL

1.1 THE REQUIREMENT

A. The CONTRACTOR shall furnish submersible compact mixers and motors with associated controls, wiring, and appurtenances, including guide bars, lifting cables, power cables, support cables, hoist base, connection brackets, nameplates and access covers, complete and operable, in accordance with the Contract Documents.

B. The system shown on the Drawings is based on the supply of the first-named Supplier, Manufacturer, or Vendor. The Drawings show a general depiction of the equipment and indicate a level of accessibility and clearances that shall be required for installation and maintenance of the system components. The specific location of system connections and equipment may vary depending on the System Supplier. Additionally, the quantity and methods used for meeting the Contract requirements for safety may differ between what is provided by the System Suppliers and what is shown on the Contract Drawings. The supplied system shall fit within the footprints shown on the Drawings while maintaining the level of accessibility and clearances shown on the Drawings. If the Contractor selects a System Suppler other than the first-named System Supplier, Contractor shall be responsible for the cost of all modifications required to provide the accessibility and clearance requirements, and modifications required of equipment that are tailored to the specific system design at no additional cost to the Owner. Such changes to the layout shall not impair the equipment accessibility or limit maintenance access as generally indicated on the Drawings, nor shall it relieve the System Supplier's responsibility for meeting the requirements of the Contract Documents. Any re-design of structures, foundations, support utilities, or any other related infrastructure needed to accommodate other than the first-named supplier shall be borne by the Contractor, without additional cost to the Owner; any such re-design of related infrastructure shall be by the Owner's design engineer. Any costs associated with the Owner's design engineer evaluation of Contractor proposed alternate System Suppliers shall be borne by the Contractor.

1.2 REFERENCE CODES, AND STANDARDS

A. Except as otherwise indicated, the current editions of the Specifications and Standards listed in Section 11000 and the following apply to the work of this Section:

ASTM A 48	Standard Specification for Gray Iron Castings
ASTM A 53	Pipe, Steel, Black and Hot-Dipped Zinc Coated, Welded and Seamless
ASTM A 283	Low and Intermediate Tensile Strength Carbon Steel Plates

1.3 REFERENCE SPECIFICATIONS:

1. Section 01340 – Shop drawings, Product Data, and Samples

2. Section 01660 – Testing and Training

3. Section 01730 - Operation and Maintenance Data

4. Section 05500 - Metal Fabrications

5. Section 09900 – Painting and Coatings.

6. Section 11000 – Equipment General Provisions

7. Section 13400 – Common Work Results Process Instrumentation and Controls

8. Section 14600 – Hoists, Cranes, and Winches

9. Section 15200 - Valves.

10. Section 16220 – Low Voltage Motors.

1.4 CONTRACTOR SUBMITTALS

A. General: CONTRACTOR shall submit administrative, shop drawings, samples, quality control, and contract closeout submittals of all equipment furnished this Section and in referenced Sections in accordance with the requirements of Section 01340 - Shop Drawings, Product Data and Samples.

B. Shop Drawings and Samples: In addition to the requirements of Section 01340 - Shop Drawings, Product Data and Samples, the CONTRACTOR shall submit the following:

1. Submersible Mixer

   a. Name of manufacturer
   b. Type and model
   c. Rotational speed
   d. Major component materials of construction

2. Mixer specification describing construction details

3. Outline dimension drawing

4. Installation drawing

5. Complete performance data showing capacity and power input

6. Electrical Data that includes:

   a. Motor rating, hp
   b. Motor temperature rating
   c. Motor full load rotational speed
   d. Motor full load current
   e. Motor locked rotor current
   f. Power cable data
   g. Motor performance curves showing speed, efficiency, current, power, etc.
   h. Moisture sensor protection characteristics and wiring diagram

7. Mixer Mast Assembly

a. Hoist and mast assembly specification
b. Hoist details and materials of construction
c. Mast assembly details and materials of construction

C. O & M Manuals: The CONTRACTOR shall provide operations and maintenance data for all equipment furnished for the project in accordance with Section 01730 - Operation and Maintenance Data.

D. Tools: Special tools necessary for maintenance and repair of the equipment shall be furnished as a part of the WORK hereunder; such tools shall be suitably stored in metal tool boxes, and identified with the equipment number by means of stainless steel or solid plastic name tags attached to the box.

1.5 QUALITY ASSURANCE:

A. CONTRACTOR shall submit the following:

1. MANUFACTURER's Certificate of Proper Installation

2. Functional Test Certification

3. Factory performance test reports

4. Special shipping, storage and protection, and handling instructions

5. MANUFACTURER's printed installation instructions

6. List of suggested spare parts to maintain the equipment in service for a period of 5 years. Include a list of special tools required for checking, testing, parts replacement, and maintenance.

7. List of special tools, materials, and supplies furnished with equipment for use prior to and during startup.

B. Warranty

1. A written suppliers warranty shall be provided for the equipment specified in this section as required in Section 11.2, General Conditions.

1.6 MANUFACTURERS SERVICE REPRESENTATIVE

A. In accordance with the requirements of Section 01660 – Testing and Training, a MANUFACTURER's Representative shall be present at the site or classroom designated by the OWNER to provide the services and minimum person-days listed below, travel time excluded.

1. One (1), eight-hour (8-hr.) days for each unit for installation assistance and final installation inspection

2. One (1), eight-hour (8-hr.) days for each unit for functional and performance testing

3. One (1), eight-hour (8-hr.) days for each unit a factory representative, who has complete knowledge of proper operation and maintenance shall be provided to instruct representatives of the OWNER and ENGINEER on proper operation and maintenance, including pre-startup, start-up and shut-down procedures, proper lubrication practices, and troubleshooting of all equipment.

PART 2 PRODUCTS

2.1 GENERAL:

Number of Mixers	1 duty per each OD and AB (4 subtotal); 2 shelf spares (6 total)
Location	OD and AB De-Ox Zones, per Drawings
Equipment No.	Per Drawings
Liquid Mixed	Mixed Liquor Activated Sludge
Design Liquid Suspended Solids Concentration Range (mg/l.)	3,000 – 6,000
Mixing Cycle	Continuous
Dimensions of Tank to be Mixed:	
Length (ft)	Per Drawings
Width (ft)	Per Drawings
Side Water Depth (ft)	13.5

Note: MANUFACTURER to review the drawings to verify the configuration of the basin and location of flows into the basin. MANUFACTURER shall provide recommended mixer installation depth, mixer angle, and mixer size to facilitate a fully mixed basin necessary to achieve denitrification and prevent settlement of biological solids at the bottom of the basins. Mixing shall not create surface splashing or vortexing at the surface that impacts the treatment process.

A. General

1. Type: Each mixer shall be submersible with the motor close-coupled directly connected to the propeller; gear box designs shall not be acceptable. The propeller shall be capable of handling solids, fibrous materials, heavy sludge, and other matter found in wastewater applications.

2. Submergence: All components of the mixer, including motor, shall be capable of continuous underwater operation in both of the following conditions: (1) mixer blade completely submerged. In addition, all components of the mixer, including motor, shall be capable of continuous operation in air, completely un-submerged, for 2 hours minimum.

3. Mounting: The mixers shall be designed as a single guide mast system, including an adjustable mixer support arm which can be set to the desired mixer depth on the guide bar, and changed if needed without drilling or tapping the guide bar. The support arm is to be made of 316 SS and be designed specifically for the mixer

being offered with an appropriate length and diameter to align with the support pad located at the base of the mixer. Once the mixer is lowered into place, the full weight of the mixer is to be carried by the support arm, assuring minimal movement of the mixer while it is under load.

4. Mating Surface Seals: All mating surfaces where watertight sealing is required shall be machined and be fitted with a double set of nitrile rubber or Viton O-rings. Fitting shall be such that sealing is accomplished by metal-to-metal contact between machined surfaces. This will result in controlled compression of the O-rings without requiring a specific torque limit. No secondary sealing compounds, rectangular gaskets, elliptical O-rings, grease or other devices shall be used.

5. Propeller: The propeller shall be non-clogging backward curved design, capable of handling solids, fibrous materials, heavy sludges, and other matter normal found in wastewater treatment applications. Propeller shall be dynamically balanced so the propeller imbalance does not exceed ISO 1940 G6.3 tolerances to prevent excessive vibrations. The propeller shall have two or three vanes and be of the diameter and of the blade angle, in degrees, as indicated. Each blade shall be laser cut and welded to the hub to ensure that the propeller is properly balanced.

6. Jet Ring Assembly: A jet ring assembly shall be provided in applications free of fibrous material as determined by manufacturer evaluation of the conditions. The mixer assembly shall incorporate a full 360 degree jet ring around the propeller. A maximum clearance of 11/2 inches shall be maintained between the propeller tip and the shroud in order to maintain hydraulic efficiency and minimize power consumption.

7. Bearings: The shaft shall rotate on two or three permanently lubricated bearings. The outboard, propeller end, bearing shall be an angular contact or deep grove bearing. The inboard, motor end, bearings shall be an angular contact or deep grove to take up the axial loads and a radial bearing to take up the radial loads. The bearings shall be pre-loaded, if needed, by a bearing loading nut located on the motor end of the shaft in order to reduce shaft deflection and increase bearing and seal life. All bearings shall have a minimum L-10 rated life of 100,000 hours.

8. Oil housing: The oil housing shall contain two compartments consisting of an inner and an outer section with four ports to connect and facilitate oil flow. In the event that the mixed media bypasses the other seal, this design will allow the outer compartment to collect the heavier (denser) fluids by means of a simple gravity process. Mixers which require propeller removal for oil change shall not be acceptable. Separate fill and drain plugs shall be provided to facilitate oil replacement.

9. Shaft: The propeller and motor shaft shall be an integral unit. The shaft shall be designed to meet the maximum loads generated by the mixer. The mixer shafts shall have machined shoulders to permit exact bearing, seal and propeller placement. Torque shall be transmitted to the propeller by a keyed shaft arrangement.

10. Shaft Seals:

a. Each mixer shall be provided with two sets of lapped end face type mechanical seals or an outside lapped end fact type mechanical seal and inner lip seal running in an oil chamber for cooling and lubrication. Shaft seals without positively driven rotating members shall not be accepted. Only the seal faces of the outer seal assembly shall be exposed to the mixed media.

b. The standard inner mechanical seal shall be corrosion resistant Tungsten Carbide/Aluminum Oxide. The outer seal faces shall be Tungsten Carbide/Tungsten Carbide. One face of the inner seal ring pair shall have spiral grooves laser etched in it, to provide a pumping action to move leakage from the stator housing back into the oil chamber. In order to avoid seal failure due to sticking, clogging, and misalignment from elements contained in the mixed media, only the seal faces of the outer seal assembly and its retaining clips shall be exposed to the mixed media. All other components shall be contained in the oil housing.

c. Each mixer shall be provided with an oil chamber for the shaft sealing system. The oil chamber shall be designed for oil pressure compensation. The drain and inspection plugs, with positive anti-leak seal, shall be easily accessible from the outside.

d. The mechanical seal shall require neither maintenance nor adjustment, shall not be damaged when the mixer is run dry, shall be easy to check and replace, shall be capable of running in either direction without damage, and be readily available from any major seal manufacturer. Shaft seals that rely on the tank fluid as a lubricant will not be considered acceptable or equal.

11. Seal shield:

a. The mixer shall be equipped with a seal shield that prevents fibrous material from winding up around the shaft and outer seal. The shield shall be welded to the propeller hub and extend towards the motor. The shield shall rotate with the propeller and there shall be a radial micro-gap between the shield and oil-housing.

B. Performance Requirements: Deox Zone 1I, 2I

Maximum Propeller Speed (rpm)	860
Maximum Propeller Diameter (inches)	14.57”
Maximum Propeller Blade Angle (degrees)	9 degrees
Drive Type	Direct
Maximum Horsepower Rating	4
Voltage, Phase, Hertz	480, 3, 60
Minimum Thrust Produced, (N)	620

A. Performance Requirements: Deox Zone 3I, 4I

Maximum Propeller Speed (rpm)	855
Maximum Propeller Diameter (inches)	14.57”
Maximum Propeller Blade Angle (degrees)	5 degrees
Drive Type	Direct
Maximum Horsepower Rating	2.5
Voltage, Phase, Hertz	480, 3, 60
Minimum Thrust Produced, (N)	360

B.

1. The mixers shall be selected, sized, designed and positioned in the basins to achieve adequate mixing at all locations in the basins as recommended and required by the MANUFACTURER to allow the complete biological system to meet all the specified performance and operational requirements.

2. Mixer systems shall be capable of providing mixing energy to each tank at no less than 0.020 horsepower per 1000 gallons.

C. Materials of Construction

1. Mixer components in contact with the liquid shall be of Type 316 stainless steel with smooth surfaces devoid of blow holes and other irregularities. All exposed nuts, bolts, fasteners, and hardware shall be of Type 316 stainless steel.

2. The propeller shall be of Type 316 stainless steel.

3. The propeller shaft shall be of Type 316, Type 420, or Type 431 stainless steel.

4. All anchor bolts nuts and washers shall be 316 stainless steel.

D. Controls

1. Control and instrumentation components shall be supplied per Section 13400 – Common Work Results Process Instrumentation and Controls, General Provisions.

2. Each motor shall be provided with temperature and moisture protection system meeting the requirements below:

   a. Provide each motor with integral solid-state temperature sensors, one in each phase.

   b. A float switch shall be installed in the seal leakage chamber and will activate if leakage into the chamber reaches 50% chamber capacity, signaling the need to schedule an inspection.

   c. Control conductors for the sensors shall be integral with the motor power cable.

   d. Sensors shall be wired to a control and status relay unit.

1) The control and status relay unit shall have the following maintained dry contact outputs rated no less than 4 amps and 12-volt, 60-Hz.

OVERTEMP (OPEN on over temperature)
OVERTEMP indicated (CLOSED on over temperature)
MOISTURE (OPEN on moisture)
MOISTURE indication (CLOSED on moisture)

e. The control and status relay unit shall be provided by the mixer supplier for mounting in the motor control center. The control and status relay shall be connected as indicated on the electrical drawings. Relay unit supply voltage shall be 120VAC.

E. Motor and Power cable

1. General: The requirements of Section 11000, apply to this section.

2. Motor: The motor and mixer shall be manufactured by the same manufacturer. The mixer motor shall be a completely sealed, electric submersible, squirrel-cage induction, shell type design, housed in an air filled watertight chamber, NEMA B type. The motor shall rated for 460 volts, 3 phase, 60 Hz. The motor shall be designed for continuous duty, capable of sustaining a minimum of 30 starts per hour. The temperature rise of the motor shall not be in excess of that specified in NEMA Standard MG1 for Class H insulating materials when operating continuously under load. The stator should be heat shrink fitted into the stator housing in order to transport heat losses most effective. The use of bolts, set screws, pins, or other fastening devices requiring penetration of the stator housing shall be rejected.

a. The mixer motor shall be a NEMA B design, induction type with a squirrel cage rotor, shell type design, housed in an air filled, watertight chamber. The stator windings shall be insulated with moisture resistant Class H insulation rated for 180oC (356oF). The stator shall be insulated by the trickle impregnation method using Class H monomer-free polyester resin resulting in a winding fill factor of at least 95%. The motor shall be inverter duty rated in accordance with NEMA MG1, Part 31.The stator shall be heat-shrink fitted into the cast iron stator housing. The use of multiple step dip and bake-type stator insulation process is not acceptable.

b. The motor horsepower shall not be less than the maximum mixer horsepower specified for each mixer and the actual horsepower shall be adequate throughout the entire range of the published curve without overloading.

c. The motors shall be designed, manufactured, and tested in accordance with the requirements and recommendations for NEMA MG 1. The motors shall comply with the latest ANSI, NEMA, and IEEE standards, and the National Electrical Code. All electrical characteristics shall be rated at 40 degrees C.

d. Motors shall be properly sized and completely compatible with the drive system supplied.

3. Power Cables

a. Each mixer shall be furnished with the necessary cables for power connection, moisture detection, and overload protection, sheathed, coded, and suitable for submersible non-clog mixers. All cables shall be connected to the mixers and tested at the factory. A minimum of 50' of power cable shall be provided.

b. Power cables shall be adequately shielded to prevent any interference if cables are installed as shown on the contract drawings.

c. The power cable shall be in accordance with all applicable electrical specifications in the contract documents.

d. Power cable shall be sized according to NEC standards and shall be supplied in lengths as required for proper installation. The motor and cable shall be capable of continuous submergence under water without loss of watertight integrity to a depth of 65 57 feet. Power cable shall be CSA approved and suitable for use in hazardous locations in accordance with NEC Class 1, Division 1, Group C and D.

e. Include necessary cables for power connection, moisture detection, and overload protection, sheathed, coded, and suitable for submersible non-clog mixers, and of sufficient length for direct connection to field panel. Wicking fillers will not be accepted. Power cables shall keep separate from cable or cables for thermal protection and moisture detection or shall be adequately shielded from sensor signal conductors to prevent interference with thermal protection and moisture detection devices.

f. The cable entry housing shall be an integral part of the back plate. The cable entry shall have a double set of elastomer grommets in order to ensure a redundant system in the event of a cable entry failure. Single sealing systems will not be deemed acceptable. The cable entry shall be comprised of two cylindrical elastomer grommets, each flanked by washers and a ferrule designed with close tolerance fit against the cable outside diameter and the entry inside diameter. This will provide a leak proof seal at the cable entrance without the need for specific torque requirements. The assembly shall bear against a shoulder in the stator casing opening and be compressed by a gland nut threaded into it. Interaction between the gland nut and the ferrule should move the grommet along the cable axially instead of with a rotary motion. The junction chamber and motor compartment shall be separated by a terminal board which shall protect the motor interior from foreign material gaining access into the mixer top. Connection shall be made between the threaded compressed type binder posts thus securely affixing the cable wires to the terminal board. The use of the terminal compressed type post and a terminal board O-ring shall render the motor compartment leak proof from any liquid which may enter the terminal compartment. Epoxies, silicones, or other secondary sealing systems shall not be considered acceptable.

g. If the cable entry is not leakproof when cable is cut below water level, the junction chamber containing the terminal board shall be hermetically sealed from the motor by elastometer compression seal (0-ring). Connection between the cable conductors and stator leads shall be made with threaded compressed type binding post permanently affixed to a terminal board.

F. Mounting and Support System

1. Each mixer shall be equipped with a mounting assembly and vertical support mast designed to secure the mixer while in operation and guide it during installation and removal without entering or emptying the tank. The vertical support mast shall be supported from the basin floor and the basin walkway as appropriate, and at 10-foot vertical intervals along the basin wall.

2. The top mast connection to the basin walkway shall be capable of being installed at positions 0-deg, 90-deg, 180-deg, and 270-deg of the installed mixer axis such that the connection can be made to a walkway located in front, to the side, or behind the mixer.

3. All components of the mounting assembly including mixer mounting base plate, vertical support mast, sliding bracket, and fastening hardware shall be Type 316 stainless steel. Support and mounting system shall be seismically designed in accordance with 01612 – Seismic Design Requirements.

4. The vertical support mast section shall be a minimum of 2-inch by 2-inch by 3/16 inch if square or 2-inch diameter schedule 10, if round. The assembly shall permit horizontal and vertical changing of the mixer axis. The assembly shall be designed and constructed to securely support the mixer, including providing adequate thrust resistance under all mixer operating conditions, including both submerged and un-submerged operation and over the full range of mixer axis positions. The mast shall be provided with a cable holder that prevents the electric cable from being entangled with the mixer propeller during operation. The mast shall be constructed to positively lock the mast in place at all operating positions.

5. The mixer shall have the capability of redirecting the center line of its jet +/-10 or +/- 20 degrees in a vertical plane and 120 degrees in a horizontal plane and can be repositioned for operation at any elevation along the complete mast assembly. The mast shall be constructed with a positioning locking plate which will work in conjunction with a bolts through the upper guide holder to positively lock the mast in place at various operating angles. All the above shall be capable of being accomplished without draining the tank.

6. Power Cable Support: Provide a minimum 1/4”-inch diameter 316 stainless steel power cable support cable shall be provided with each mixer and be permanently attached to the mixer shackle on one end and the upper guide bracket of the mounting system on the other end. The power cable shall be attached to the support cable using sway clamps at a minimum of 5 feet intervals.

7. Lifting Cable: Provide a minimum 1/4"-inch diameter, 316 stainless steel lifting chain shall be provided and securely attached to each mixer. The top of the cable shall end in an eye of sufficient strength to develop the strength of the cable. Provide a hook to secure the cable at the top of the mast.

G. Accessories

1. Lifting Lugs: Equipment weighing over 100 pounds shall be provided with lifting lugs.

2. Identification Plate: An identification plate shall be securely mounted on the equipment in a readily visible location. The plate shall bear the 1/4 inch die-stamped equipment identification number and equipment data.

3. Anchors: Concrete anchors shall be in conformance with Section 05500 - Miscellaneous Metals, and minimum 5/8-inch diameter. Coordinate required size and location with Shop Drawings. The mixer MANUFACTURER shall determine the proper location for anchors.

H. Hoist or Crane Systems

1. Complete portable hoists or davit crane systems shall be provided by the CONTRACTOR or EQUIPMENT SUPPLIER to provide a complete and coordinated lifting system designed for the specified equipment.

2. CONTRACTOR shall provide all remaining hoist or crane mounting sockets not provided in the pump manufacturer scope of supply. All hoist or crane mounting sockets shall be of the same type and manufacturer.

3. Hoist or Crane mounting sockets: Provide flush mounted or wall mounted sockets as shown on the Drawings and described in Section 14600 – Hoists, Cranes, and Winches.

4. Hoists or Cranes: Provide hoists, cranes, lifting assemblies, wire, and winches as shown on the Drawings and described in Section 14600 – Hoists, Cranes, and Winches.

I. Spare parts:

1. Each size and type of mixer shall be supplied with the following parts:

a. Two sets motor shaft bearings.

b. Two sets seals, gaskets, and O-rings.

2. Shelf spares:

a. Provide one (1) shelf spare mixer designed for Deox Zones 1I & 2I

b. Provide one (1) shelf spare mixer designed for Deox Zones 3I & 4I

J. Protective coating

1. Shop and field painting shall be in accordance with requirements specified in Section 09900 - Paints and Coating.

K. Manufacturers

1. MANUFACTURER's Experience: The materials and equipment covered by this specification are intended to be standard materials and equipment of demonstrated successful performance and supplied by a MANUFACTURER who has been actively engaged in the supply of similarly sized submersible mixers for a minimum of 5 years. Equipment shall be designed and constructed in accordance with the highest standards of the industry and shall be installed in

accordance with the MANUFACTURER's recommendations and the Contract Documents.

2. Unit Responsibility: The mixer and accessories specified herein shall be the design and fabrication of a single MANUFACTURER which shall have the sole source responsibility for the mixers and associated accessories. To ensure the integrity of the mounting system the mixer MANUFACTURER shall supply the support guide brackets and the square mast.

3. Manufacturers or Approved Equal:

   a. Flygt Corporation, 4600 Series (4640 for OD, 4630 for AB)

   b. ABS

PART 3 EXECUTION

3.1 DELIVERY AND STORAGE

A. A complete set of MANUFACTURER's instructions covering storage, installation, operation, lubrication, and maintenance shall be furnished to the OWNER no later than the date the equipment is shipped. Care during storage and procedures for installation, lubrication, and startup of the equipment and motors shall be in strict conformance with the MANUFACTURER's instructions.

3.2 INSTALLATION

A. Install in accordance with the MANUFACTURER's printed instructions.

3.3 TESTING

A. Factory Testing: Mixers shall be witness-tested at the factory. Testing shall include the following:

   1. Verify that propeller, motor rating, and electrical connections comply with this Section.

   2. Measure for moisture content and insulation defects in motor and cable, both before and after the submergence test below.

   3. Run mixer dry to verify proper rotation and alignment.

   4. Run mixer submerged at least 30 minutes under at least 6 feet of water to check for balance, unusual noise, and overheating. Verify proper pumping capacity.

   5. Test motor for no-load current at rated voltage, high potential, and locked rotor current.

   6. A factory test report showing that the above testing procedure has been performed and that the mixer successfully passed the tests shall be completed. The factory test report shall be supplied with the final documents.

B. Functional Testing: A functional wet test shall be conducted at plant startup in accordance with Section 01660 - Testing and Training. The functional wet test should verify operation without excessive noise, vibration, cavitation, or overheating and document motor voltage and current draw.

C. Performance Testing: A factory trained representative shall inspect the installation of the mixers before the basins are filled and before start up to assure the installation has been completed in accordance with the MANUFACTURER's recommendations. Start up of the mixers shall be in accordance with the MANUFACTURER's recommended start up procedures. An installation start up form shall be completed for each mixer and supplied with the final documents. Start up should take no more than 2-3 hours per mixer. A functional wet test shall be conducted at plant startup in accordance with Section 01660 - Testing and Training. Verify operation without excessive noise, vibration, cavitation, or overheating. Document motor voltage and current draw.

END OF SECTION

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SECTION 11206 – SUBMERSIBLE LOW SPEED MIXERS

PART 1 GENERAL

1.1 THE REQUIREMENT

A. The CONTRACTOR shall furnish submersible low speed mixers and motors with associated controls, wiring, and appurtenances, including guide bars, lifting cables, power cables, support cables, hoist base, connection brackets, nameplates and access covers, complete and operable, in accordance with the Contract Documents.

B. The system shown on the Drawings is based on the supply of the first-named Supplier, Manufacturer, or Vendor. The Drawings show a general depiction of the equipment and indicate a level of accessibility and clearances that shall be required for installation and maintenance of the system components. The specific location of system connections and equipment may vary depending on the System Supplier. Additionally, the quantity and methods used for meeting the Contract requirements for safety may differ between what is provided by the System Suppliers and what is shown on the Contract Drawings. The supplied system shall fit within the footprints shown on the Drawings while maintaining the level of accessibility and clearances shown on the Drawings. If the Contractor selects a System Suppler other than the first-named System Supplier, Contractor shall be responsible for the cost of all modifications required to provide the accessibility and clearance requirements, and modifications required of equipment that are tailored to the specific system design at no additional cost to the Owner. Such changes to the layout shall not impair the equipment accessibility or limit maintenance access as generally indicated on the Drawings, nor shall it relieve the System Supplier's responsibility for meeting the requirements of the Contract Documents. Any re-design of structures, foundations, support utilities, or any other related infrastructure needed to accommodate other than the first-named supplier shall be borne by the Contractor, without additional cost to the Owner; any such re-design of related infrastructure shall be by the Owner's design engineer. Any costs associated with the Owner's design engineer evaluation of Contractor proposed alternate System Suppliers shall be borne by the Contractor.

1.2 REFERENCE SPECIFICATIONS, CODES, AND STANDARDS

A. Except as otherwise indicated, the current editions of the Specifications and Standards listed in Section 11000 – Equipment General Provisions and the following apply to the work of this Section:

ASTM A 48	Standard Specification for Gray Iron Castings
ASTM A 53	Pipe, Steel, Black and Hot-Dipped Zinc Coated, Welded and Seamless
ASTM A 283	Low and Intermediate Tensile Strength Carbon Steel Plates

1.3 REFERENCE SPECIFICATIONS:

1. Section 01340 – Shop drawings, Product Data, and Samples

2. Section 01660 – Testing and Training

3. Section 01730 - Operation and Maintenance Data

4. Section 05500 - Metal Fabrications

5. Section 09900 – Painting and Coatings.

6. Section 11000 – Equipment General Provisions

7. Section 11100 – Pumps, General

8. Section 13400 – Common Work Results Process Instrumentation and Controls

9. Section 14600 – Hoists, Cranes, and Winches

10. Section 15200 - Valves.

11. Section 16220 - Motors.

12. Section 16481 - Variable Frequency Drives.

1.4 CONTRACTOR SUBMITTALS

A. General: CONTRACTOR shall submit administrative, shop drawings, samples, quality control, and contract closeout submittals of all equipment furnished this Section and in referenced Sections in accordance with the requirements of Section 01340 - Shop Drawings, Product Data and Samples.

B. Shop Drawings and Samples: In addition to the requirements of Section 01340 - Shop Drawings, Product Data and Samples, the CONTRACTOR shall submit the following:

1. Submersible Mixer

   a. Name of manufacturer
   b. Type and model
   c. Rotational speed
   d. Major component materials of construction

2. Mixer specification describing construction details

3. Outline dimension drawing

4. Installation drawing

5. Complete performance data showing capacity and power input

6. Electrical Data that includes:

   a. Motor rating, hp
   b. Motor temperature rating
   c. Motor full load rotational speed
   d. Motor full load current
   e. Motor locked rotor current
   f. Power cable data
   g. Motor performance curves showing speed, efficiency, current, power, etc.
   h. Moisture sensor protection characteristics and wiring diagram

7. Mixer Mast Assembly

   a. Hoist and mast assembly specification
   b. Hoist details and materials of construction
   c. Mast assembly details and materials of construction

C. O & M Manuals: The CONTRACTOR shall provide operations and maintenance data for all equipment furnished for the project in accordance with Section 01730 - Operation and Maintenance Data.

D. Tools: Special tools necessary for maintenance and repair of the equipment shall be furnished as a part of the WORK hereunder; such tools shall be suitably stored in metal tool boxes, and identified with the equipment number by means of stainless steel or solid plastic name tags attached to the box.

1.5 QUALITY ASSURANCE:

A. CONTRACTOR shall submit the following:

1. MANUFACTURER's Certificate of Proper Installation

2. Functional Test Certification

3. Factory performance test reports

4. Special shipping, storage and protection, and handling instructions

5. MANUFACTURER's printed installation instructions

6. List of suggested spare parts to maintain the equipment in service for a period of 5 years. Include a list of special tools required for checking, testing, parts replacement, and maintenance.

7. List of special tools, materials, and supplies furnished with equipment for use prior to and during startup.

B. Warranty

1. A written suppliers warranty shall be provided for the equipment specified in this section as required in accordance with the General Conditions.

1.6 MANUFACTURERS SERVICE REPRESENTATIVE

A. In accordance with the requirements of Section 01660– Testing and Training, a MANUFACTURER's Representative shall be present at the site or classroom designated by the OWNER to provide the services and minimum person-days listed below, travel time excluded.

1. One (1), four-hour (4-hr.) days for each unit in each aeration train for installation assistance and final installation inspection (3 total days each for Oxidation Ditch 1 and 2; 2 total days each for Aeration Basin 3 and 4).

2. One (1), four-hour (4-hr.) days for each unit in each train for functional and performance testing (3 total days each for Oxidation Ditch 1 and 2; 2 total days each for Aeration Basin 3 and 4).

3. One (1), eight-hour (8-hr.) days for each aeration train for a factory representative, who has complete knowledge of proper operation and maintenance shall be provided to instruct representatives of the OWNER and ENGINEER on proper operation and maintenance, including pre-startup, start-up and shut-down procedures, proper lubrication practices, and troubleshooting of all equipment.

PART 2 PRODUCTS

2.1 GENERAL:

Number of Mixers	22 total, see below
OD 1 and 2 – Anoxic Zone A	1 ea. (2 total)
OD 1 and 2 – Anoxic Zone B	1 ea. (2 total)
OD 1 and 2 – Anoxic Zone C	2 ea. (4 total)
OD 1 and 2 – Anoxic Zone D	2 ea. (4 total)
AB 3 and 4 – Anoxic Zone A	1 ea. (2 total)
AB 3 and 4 – Anoxic Zone B	1 ea. (2 total)
AB 3 and 4 – Anoxic Zone C	1 ea. (2 total)
AB 3 and 4 – Anoxic Zone D	1 ea. (2 total)
Shelf Spares	2 total
Location	OD and AB Anoxic Zones, per Drawings
Equipment No.	Per Drawings
Liquid Mixed	Mixed Liquor Activated Sludge
Design Liquid Suspended Solids Concentration Range (mg/l.)	3,000 – 6,000
Mixing Cycle	Continuous
Dimensions of Tank to be Mixed:	
Length (ft)	Per Drawings
Width (ft)	Per Drawings
Side Water Depth (ft)	13.5

Note: MANUFACTURER to review the drawings to verify the configuration of the basin and location of flows into the basin. MANUFACTURER shall provide recommended mixer installation depth, mixer angle, and mixer size to facilitate a fully mixed basin necessary to achieve denitrification and prevent settlement of biological solids at the bottom of the basins. Mixing shall not create surface splashing or vortexing at the surface that impacts the treatment process.

A. General

1. Type: Each mixer shall be submersible with a high efficiency synchronous speed motor with an integrated variable speed drive, housed in an air filled, watertight chamber. The propeller shall be capable of handling solids, fibrous materials, heavy sludge, and other matter found in wastewater applications.

2. Submergence: All components of the mixer, including motor, shall be capable of continuous underwater operation in both of the following conditions: (1) mixer blade completely submerged. In addition, all components of the mixer, including motor, shall be capable of continuous operation in air, completely un-submerged, for 2 hours minimum.

3. Gear unit: The gear box shall be of a two-stage helical type equipped with high precision, low loaded gears. The motor shaft shall be provided with an integral driving gear. The intermediate shaft shall rotate in two spherical roller bearings and contain a second driving gear. The propeller shaft shall contain the second driven gear and rotate in one single row and one double row angular contact ball bearing or roller bearing.

4. Mounting: The mixer mast shall be designed in such a way that the mixer can be lowered onto and off of the mast without the need for workers to reach down and/or forward and remove a pin to release the mixer from the mast or to allow the mixer to be installed on the mast. When located at its final resting position on the mast, the entire weight of the mixer shall be borne by the horizontal arm which is permanently and securely attached to the vertical 4” x 4” mast assembly.

5. Mating Surface Seals: All mating surfaces where watertight sealing is required shall be machined and be fitted with a double set of nitrile rubber or Viton O-rings. Fitting shall be such that sealing is accomplished by metal-to-metal contact between machined surfaces. This will result in controlled compression of the O-rings without requiring a specific torque limit. No secondary sealing compounds, rectangular gaskets, elliptical O-rings, grease or other devices shall be used.

6. Propeller shaft and propeller:

   a. The propeller shaft shall be made of stainless steel ASTM/AISI 431 or EN10088-3-1.4057, or comparable.

   b. The propeller shall consist of fiberglass reinforced polyurethane blades each integrated with stainless steel shaft for mounting in a cast iron hub. Each blade shall be mounted into a socket in the side of the hub. The propeller shaft shall be bolted axially to the hub. The propeller blade shape shall be a clogging-resistant, back-swept design which starts at the hub leaving no part of the shaft exposed.

7. Bearings: The motor shaft shall rotate on two permanently lubricated bearings. The inner bearing shall be single row deep grove ball bearing and the main bearing a spherical roller bearing. All bearings shall have a minimum L-10 rated life of 100,000 hours.

8. Oil housing: The oil housing shall contain two compartments consisting of an inner and an outer section with four ports to connect and facilitate oil flow. In the event that the mixed media bypasses the other seal, this design will allow the outer compartment to collect the heavier (denser) fluids by means of a simple gravity process. Mixers which require propeller removal for oil change shall not be

acceptable. Separate fill and drain plugs shall be provided to facilitate oil replacement.

9. Shaft Seals:

   a. Each mixer shall have an oil chamber for the shaft sealing system, and a second separate oil chamber for the gear box. Plugs for drainage and inspection of the oil shall be easily accessible from the outside. Each mixer shall be provided with three seals to separate the various parts of the mixer. The outer seal on the propeller shaft shall be a mechanical seal made of corrosion resistant cemented carbide (WCCR). The seals shall operate in an oil reservoir that hydrodynamically lubricates the seal faces at a constant rate. Only the seal faces of the outer seal shall be exposed to the mixed media. The inner seal on the propeller shaft shall be a nitrile rubber lip seal isolating the propeller shaft oil chamber from the gear box oil chamber. The third seal shall be a viton rubber lip seal mounted on the motor shaft to isolate the gear box oil chamber from the stator housing. The seals shall require neither maintenance nor adjustment.

10. Oil: The oil chamber shall be filled with a medical white oil of paraffin type. The oil shall be free from aromatic hydrocarbons and be approved according to FDA 172.878. The gear box chamber shall be filled with a gear box oil of type Mobilgear 630 or similar.

B. Performance Requirements: Anoxic Zones 1A, 1B, 2A, 2B, 3A, 3B, 4A, 4B

Maximum Propeller Speed (rpm)	30
Maximum Propeller Diameter (inches)	78”
Maximum Propeller Blade Angle (degrees)	To be specified by Manufacturer
Speed	Variable
Minimum Horsepower Rating	2.7
Voltage, Phase, Hertz	480, 3, 60
Minimum Thrust Produced, (N)	887

C. Performance Requirements: Anoxic Zones 1C, 1D, 2C, 2D, 3C, 3D, 4C, 4D

Maximum Propeller Speed (rpm)	30
Maximum Propeller Diameter (inches)	98”
Maximum Propeller Blade Angle (degrees)	To be specified by Manufacturer
Speed	Variable
Minimum Horsepower Rating	2.7
Voltage, Phase, Hertz	480, 3, 60
Minimum Thrust Produced, (N)	742

1. The mixers shall be selected, sized, designed and positioned in the basins to achieve adequate mixing at all locations in the basins as recommended and required by the MANUFACTURER to allow the complete biological system to meet all the specified performance and operational requirements.

2. Mixer systems shall be capable of providing mixing energy to each tank at no less than 0.020 horsepower per 1000 gallons.

D. Materials of Construction

1. Major mixer components excluding stand and propeller blades shall be of grey cast iron, ASTM A-48 Class 35B, or EN1561-GJL250 with smooth surfaces devoid of blow holes or other irregularities. All cast iron surfaces coming in contact with the mixed liquid shall be protected by a factory applied spray top coat of oxiranesther (Duasolid) paint finish on the exterior of the mixer. Nuts and bolts shall be made of stainless steel AISI 316 or better.

2. The propeller shall be of fibreglass reinforced polyurethane blades each integrated with stainless steel shaft for mounting in a cast iron hub.

3. The propeller shaft shall be of stainless steel ASTM/AISI 431 or EN10088-3-1.4057, or comparable.

4. All anchor bolts nuts and washers shall be 316 stainless steel.

E. Controls

1. Control and instrumentation components shall be supplied per Section 13400 – Common Work Results Process Instrumentation and Controls.

2. The mixer speed shall be adjustable via either remote communications or a separate operator panel.

   a. The mixer shall be capable of communicating with a SCADA or other machine communication systems directly, either using a Modbus RTU or PDU communications structure. The mixer communication protocol is to be designed to operate with, or without, a master controller. Allowed commands must include start, stop, reference frequency and configuration of settings. A heart beat signal should be provided to verify connectivity with the mixer.

      1) Parameters that must be readable remotely include:
         a) Current Motor Power Consumption
         b) kW – hours
         c) Running time
         d) Alarm Status
         e) Alarm Details - such as:
         f) Mixer internal over temperature
         g) Mixed fluid over temperature
         h) Overcurrent (excessive load)
         i) Communication failure
         j) Power electronics (VFD) diagnostics
         k) Leakage alarm (if purchased)

b. Controls must give the operator the ability to define how the mixer reacts to a leakage alarm, and to set a ramp up and ramp down time for the soft start and stop functions.

c. The mixer must also be user configurable to either start on its own whenever 3 phase power is provided, or require re-established communications before resuming. All settings must be stored in non-volatile memory within the mixer enabling it to resume normal operation when power is restored even if communication is not.

3. The mixer vendor must provide an operator panel which can be mounted near the tank and provide access to the functionality listed above.

4. Each motor shall be provided with temperature and moisture protection system meeting the requirements below:

a. Provide each motor housing with integral solid-state temperature sensors, one in each phase.

b. A float switch shall be installed in the seal leakage chamber and will activate if leakage into the chamber reaches 50% chamber capacity, signaling the need to schedule an inspection.

c. Control/communication conductors for the sensors shall be integral with the motor power cable.

d. Sensors shall be wired to a control and status relay unit. Note: The unit, if connected to MODBUS, will require 24V DC power.

1) The control and status relay unit shall have the following maintained dry contact outputs rated no less than 4 amps and 12-volt, 60-Hz.

OVERTEMP (OPEN on over temperature)
OVERTEMP indicated (CLOSED on over temperature)
MOISTURE (OPEN on moisture)
MOISTURE indication (CLOSED on moisture)

e. The control and status relay unit shall be provided by the mixer supplier for mounting in the motor control center. The control and status relay shall be connected as indicated on the electrical drawings. Relay unit supply voltage shall be 120VAC.

5. Mixers not containing integrated variable speed drives: Mixers not containing integrated variable speed drives shall be provided with simplex, remote, variable speed control panels suitable for indoor control room mounting as well as a local control panel mounted on the walkway in the vicinity of each mixer.

a. The remote panel shall be constructed in a NEMA 1 painted steel enclosure and include an adjustable speed controller that will vary the speed of the mixer based upon process input. It shall also include a main power distribution block, lightning arrestor, control transformer 240-24 volt, motor circuit breaker with disconnect switch and motor starter NEMA FVNR.

b. The local control panel shall be constructed in a NEMA 4X stainless steel enclosure. It shall include a keypad or potentiometer to vary the mixer speed, Hand-Off-Auto (HOA) switch, control relay to detect motor over temperature and leakage, alarm horn, alarm beacon and space heater. With the HOA switch in the Auto position the mixer speed will be controlled from the remote control panel. With the HOA switch in the Hand position the mixer speed will be controlled from the local keypad or potentiometer. With the HOA switch in the Off position the mixer will not operate.

c. The VFDs shall be 18 pulse low harmonic drives with preconfigured soft start and soft stop functionality. The contractor shall be responsible for the compatibility and coordination of the mixers and the VFDs.

d. UNIT RESPONSIBILITY

1) Unit responsibility for the VFDs in this section shall also be as specified in Section 11000. The Contractor shall submit letters of certification with the shop drawings from the VFD manufacturer, the motor manufacturer, and the driven equipment manufacturer stating that they have reviewed each application and that the combination will satisfy the application duties required, for the actual motor sizes required, regardless of deviations from the scheduled "nominal horsepower."

2) Unit responsibility for the VFDs in this section shall also be as specified in Section 11000. The Contractor shall submit letters of certification with the shop drawings from the VFD manufacturer, the motor manufacturer, and the driven equipment manufacturer stating that they have reviewed each application and that the combination will satisfy the application duties required, for the actual motor sizes required, regardless of deviations from the scheduled "nominal horsepower."

F. Motor and Power cable

1. General: The requirements of Section 11000 – Equipment General Provisions, apply to this section.

2. Motor: The mixer shall have a high efficiency synchronous speed motor with an integrated variable speed drive, housed in an air filled, watertight chamber. The motor efficiency shall be equivalent to IE4 levels. The mixer speed shall be adjustable via either remote communications or a separate operator panel. The drive shall monitor temperature and current and stop the mixer in case of overload. The stator windings and stator leads shall be insulated with moisture resistant Class H (180 ^{o}C) insulation. The stator shall be trickle impregnated with Class H varnish and shall be force fitted into the stator housing. The motor shall be capable of an unlimited number starts per hour.

a. The motor horsepower shall not be less than the maximum mixer horsepower specified for each mixer and the actual horsepower shall be adequate throughout the entire range of the published curve without overloading.

b. The motors shall be designed, manufactured, and tested in accordance with the requirements and recommendations for NEMA MG 1. The motors shall comply with the latest ANSI, NEMA, and IEEE standards, and the National Electrical Code. All electrical characteristics shall be rated at 40 degrees C.

c. Motors shall be properly sized and completely compatible with the drive system supplied.

d. The motor efficiency shall be equivalent to IEC standard 60034-30-01 for international efficiency, class IE4 levels.

3. Power Cables

a. Each mixer shall be furnished with the necessary cables for power connection, moisture detection, and overload protection, sheathed, coded, and suitable for submersible non-clog mixers. All cables shall be connected to the mixers and tested at the factory.

b. Power cables shall be adequately shielded to prevent any interference if cables are installed as shown on the contract drawings.

c. The power cable shall be in accordance with all applicable electrical specifications in the contract documents.

d. Power cable shall be sized according to NEC standards and shall be supplied in lengths as required for proper installation. The motor and cable shall be capable of continuous submergence under water without loss of watertight integrity to a depth of 65 57 feet. Power cable shall be CSA approved and suitable for use in hazardous locations in accordance with NEC Class 1, Division 1, Group C and D.

e. Include necessary cables for power connection, moisture detection, and overload protection, sheathed, coded, and suitable for submersible non-clog mixers, and of sufficient length for direct connection to field panel. Wicking fillers will not be accepted. Power cables shall keep separate from cable or cables for thermal protection and moisture detection or shall be adequately shielded shielded from sensor signal conductors to prevent interference with thermal protection and moisture detection devices.

f. The cable entry seal shall consist of cylindrical elastomer bushings, without epoxies, silicones or other secondary sealing systems.

g. If the cable entry is not leakproof when cable is cut below water level, the junction chamber containing the terminal board shall be hermetically sealed from the motor by elastometer compression seal (0-ring). Connection between the cable conductors and stator leads shall be made with threaded compressed type binding post permanently affixed to a terminal board.

G. Gear Unit

1. The gear box shall be of a two-stage helical type equipped with high precision, low loaded gears. The motor shaft shall be provided with an integral driving gear. The intermediate shaft shall rotate in two spherical roller bearings and contain a

second driving gear. The propeller shaft shall contain the second driven gear and rotate in one single row and one double row angular contact ball bearing or roller bearing.

H. Mounting and Support System

1. Each mixer shall be equipped with a mounting assembly and vertical support mast designed to secure the mixer while in operation and guide it during installation and removal without entering or emptying the tank. The vertical support mast shall be supported from the basin floor as appropriate.

2. All components of the mounting assembly including mixer mounting base plate, vertical support mast, sliding bracket, and fastening hardware shall be Type 316 stainless steel. Support and mounting system shall be seismically designed in accordance with 01612 – Seismic Design Requirements.

3. The assembly shall consist of a 4 by 4 inch (with minimum wall thickness of 3/16 inch) mast with tripod base and horizontal support arm, to affect transfer of forces from operation of the mixer to the floor or base.

4. The mast shall be provided with adequate length for the depth of the basins and cut to final length during installation.

5. The horizontal support arm on which the mixer is set for operation shall also have a reinforcing brace, welded to the 4” by 4” square mast. The mast assembly shall be rigidly designed and therefore must be unidirectional.

6. The mixer mast shall be designed in such a way that the mixer can be lowered onto and off of the mast without the need for workers to reach down and/or forward and remove a pin to release the mixer from the mast or to allow the mixer to be installed on the mast. When located at its final resting position on the mast, the entire weight of the mixer shall be borne by the horizontal arm which is permanently and securely attached to the vertical 4” x 4” mast assembly.

7. The vertical support mast section shall permit horizontal and vertical changing of the mixer axis. The assembly shall be designed and constructed to securely support the mixer, including providing adequate thrust resistance under all mixer operating conditions, including both submerged and un-submerged operation and over the full range of mixer axis positions. The mast shall be provided with a cable holder that prevents the electric cable from being entangled with the mixer propeller during operation. The mast shall be constructed to positively lock the mast in place at all operating positions.

8. The mixer shall have the capability of redirecting the center line +/-10 or +/- 20 degrees in a vertical plane and 120 degrees in a horizontal plane and can be repositioned for operation at any elevation along the complete mast assembly. The mast shall be constructed with a positioning locking plate which will work in conjunction with a bolts through the upper guide holder to positively lock the mast in place at various operating angles. All the above shall be capable of being accomplished without draining the tank.

9. Power Cable Support: Provide a minimum 1/4”-inch diameter 316 stainless steel power cable support cable shall be provided with each mixer and be permanently attached to the mixer shackle on one end and the upper guide bracket of the

mounting system on the other end. The power cable shall be attached to the support cable using sway clamps at a minimum of 5 feet intervals.

10. Lifting Cable: Provide a minimum 1/4"-inch diameter, 316 stainless steel lifting chain shall be provided and securely attached to each mixer. The top of the cable shall end in an eye of sufficient strength to develop the strength of the cable. Provide a hook to secure the cable at the top of the mast.

I. Accessories

1. Lifting Lugs: Equipment weighing over 100 pounds shall be provided with lifting lugs.

2. Identification Plate: An identification plate shall be securely mounted on the equipment in a readily visible location. The plate shall bear the 1/4 inch die-stamped equipment identification number and equipment data.

3. Anchors: Concrete anchors shall be in conformance with Section 05500 – Miscellaneous Metals, and minimum 5/8-inch diameter. Coordinate required size and location with Shop Drawings. The mixer MANUFACTURER shall determine the proper location for anchors.

J. Hoist or Crane mounting sockets: Provide flush mounted or wall mounted sockets Hoist or Crane Systems

1. Complete portable hoists or davit crane systems shall be provided by the CONTRACTOR or EQUIPMENT SUPPLIER to provide a complete and coordinated lifting system designed for the specified equipment.

2. CONTRACTOR shall provide all remaining hoist or crane mounting sockets not provided in the pump manufacturer scope of supply. All hoist or crane mounting sockets shall be of the same type and manufacturer.

3. Hoist or Crane mounting sockets: Provide flush mounted or wall mounted sockets as shown on the Drawings and described in Section 14600 – Hoists, Cranes, and Winches.

4. Hoists or Cranes: Provide hoists, cranes, lifting assemblies, wire, and winches as shown on the Drawings and described in Section 14600 – Hoists, Cranes, and Winches.

K. Spare parts:

1. Each mixer shall be supplied with the following parts:

a. Two sets motor shaft bearings.

b. Two sets seals, gaskets, and O-rings.

2. Shelf spares:

a. Provide one (1) shelf spare mixer designed for Anoxic Zones A & B with 78” diameter blades.

b. Provide one (1) shelf spare mixer designed for Anoxic Zones C & D with 988” diameter blades.

L. Protective coating

1. Shop and field painting shall be in accordance with requirements specified in Section 09900 - Painting and Coatings.

M. Manufacturers

1. MANUFACTURER’s Experience: The materials and equipment covered by this specification are intended to be standard materials and equipment of demonstrated successful performance and supplied by a MANUFACTURER who has been actively engaged in the supply of similarly sized submersible mixers for a minimum of 5 years. Equipment shall be designed and constructed in accordance with the highest standards of the industry and shall be installed in accordance with the MANUFACTURER’s recommendations and the Contract Documents.

2. Unit Responsibility: The mixer and accessories specified herein shall be the design and fabrication of a single MANUFACTURER which shall have the sole source responsibility for the mixers and associated accessories. To ensure the integrity of the mounting system the mixer MANUFACTURER shall supply the support guide brackets and the square mast.

3. Manufacturers or Approved Equal:

a. Flygt Corporation, 4300 Series (4320)

b. ABS

PART 3 EXECUTION

3.1 DELIVERY AND STORAGE

A. A complete set of MANUFACTURER’s instructions covering storage, installation, operation, lubrication, and maintenance shall be furnished to the OWNER no later than the date the equipment is shipped. Care during storage and procedures for installation, lubrication, and startup of the equipment and motors shall be in strict conformance with the MANUFACTURER’s instructions.

3.2 INSTALLATION

A. Install in accordance with the MANUFACTURER’s printed instructions.

3.3 TESTING

A. Factory Testing: Mixers shall be witness-tested at the factory to ISO 21630 standards. Testing shall include the following:

1. Verify that propeller, motor rating, and electrical connections comply with this Section.

2. Measure for moisture content and insulation defects in motor and cable, both before and after the submergence test below.

3. Run mixer dry to verify proper rotation and alignment.

4. Run mixer submerged at least 30 minutes under at least 6 feet of water to check for balance, unusual noise, and overheating. Verify proper pumping capacity.

5. Test motor for no-load current at rated voltage, high potential, and locked rotor current.

6. A factory test report showing that the above testing procedure has been performed and that the mixer successfully passed the tests shall be completed. The factory test report shall be supplied with the final documents.

B. Functional Testing: A functional wet test shall be conducted at plant startup in accordance with Section 01660 —Testing and Training. The functional wet test should verify operation without excessive noise, vibration, cavitation, or overheating and document motor voltage and current draw.

C. Performance Testing: A factory trained representative shall inspect the installation of the mixers before the basins are filled and before start up to assure the installation has been completed in accordance with the MANUFACTURER's recommendations. Start up of the mixers shall be in accordance with the MANUFACTURER's recommended start up procedures. An installation start up form shall be completed for each mixer and supplied with the final documents. Start up should take no more than 2-3 hours per mixer. A functional wet test shall be conducted at plant startup in accordance with Section 01660 - Testing and Training. Verify operation without excessive noise, vibration, cavitation, or overheating. Document motor voltage and current draw.

END OF SECTION

SECTION 11230 – CLARIFIER/SEDIMENTATION TANKS, GENERAL

PART 1 GENERAL

1.1 THE REQUIREMENT

A. The CONTRACTOR shall furnish and install all clarifiers, skimmers, and sludge collectors as specified below and in accordance with the requirements of the Contract Documents.

Description	Value
Quantity	1
Type	Circular, center feed
Equipment No.	34-ME-01-ML

1.2 REFERENCE SPECIFICATIONS, CODES, AND STANDARDS

A. Codes: All codes, as referenced herein, are specified in Section 01090, References.

B. Commercial Standards:

ASTM A36	Specification for Structural Steel.
ASTM D570	Test Methods for Water Absorption of Plastics.
ASTM D638	Test Method for Tensile Properties of Plastics.
ASTM D732	Test Method for Shear Strength of Plastics by Punch Tool.
ASTM D2585	Method for Preparation and Tension Testing of Filament-Wound Pressure Vessels.
AGMA 908-B	Geometry Factors for Determining the Pitting Resistance and Bending Strength of Spur, Helical and Herringbone Gear Teeth.
AGMA 2001-B	Fundamental Rating Factors and Calculation Methods for Involute Spur and Helical Gear Teeth.
AGMA 6034-A	Practice for Enclosed Cylindrical Worm Gear Speed Reducers and Gear Motors.

1.3 CONTRACTOR SUBMITTALS

A. General: CONTRACTOR shall submit administrative, shop drawings, samples, quality control, and contract closeout submittals of all equipment furnished this Section and in referenced Sections.

B. Shop Drawings and Samples: Shop drawings and samples shall be submitted in accordance with the requirements of Section 01340 Shop Drawings, Product Data and Samples. The submittals shall include, but not be limited to, the following information:

1. Complete certified equipment drawings, showing all dimensions, weights, materials of construction, welds, torque ratings, etc.

2. Complete structural and seismic calculations for anchor bolts and flocculation well.

3. Electric motor data, voltage, and electrical characteristics.

4. Foundation, installation, and grouting plans.

5. Walkways, handrails, and kickplates.

6. Anchor bolts, bolts, nuts, sleeves, and inserts.

7. Equipment drive and drive guards.

8. List of spare parts to be furnished, as suggested by the manufacturer.

9. Operating and maintenance instructions.

10. List of special tools to be furnished.

11. Lubricating instructions and lubricants for one year's operation.

12. Services of manufacturer's representative.

13. Nameplate.

14. A list of the three most recent reference installations, where similar equipment by the manufacturer is currently in service, including contact name, telephone number, and address.

15. Overall interconnection schematics are required by Section 16000, Common Work Results for Electrical. The supplier of the systems specified in this Section shall provide information and prepare documentation as required in the development and submission of the interconnection schematics.

C. O & M Manuals: The CONTRACTOR shall provide operators and maintenance data for all equipment furnished for the project in accordance with Section 01730, Operation and Maintenance Data.

D. Tools: Special tools necessary for maintenance and repair of the equipment shall be furnished as a part of the WORK hereunder; such tools shall be suitably stored in metal

tool boxes, and identified with the equipment number by means of stainless steel or solid plastic name tags attached to the box.

1.4 QUALITY ASSURANCE

A. All parts of the equipment shall be amply proportioned for long, continuous, uninterrupted service. Provision shall be made for easy access for service or replacement of parts. Corresponding parts of multiple units shall be interchangeable. Workmanship shall be first class, with all welding in accordance with the latest applicable code of the American Welding Society. The complete drive mechanism shall be designed for the maximum continuous running torque per AGMA 908-B and 2001-B for a minimum life of 20 years or 175,000 hours, unless otherwise specified, and a momentary peak (stalled) torque of twice the maximum continuous running torque. The maximum allowable stresses on structural steel members shall not exceed those permitted by the latest AISC specifications for applicable design, at twice the maximum continuous running torque.

B. The equipment components shall be designed to minimize field erection requirements. No field welding will be accepted except at the access walkway bridge splice and rake to rake/cage connections. All major equipment sections shall be factory assembled requiring only field bolting of major equipment sections to each other to form the assembled equipment.

C. Certification: A certificate of design, signed by a Registered Professional Engineer, shall be submitted to the ENGINEER, prior to the manufacture of the equipment. The certificate shall include the following information:

1. Codes and Specifications followed in the design.

2. Type and strength of materials for members.

3. Loading conditions used for the design.

4. Certification that equipment is designed to withstand maximum continuous running torque and momentary peak (stalled) torque specified.

D. Warranty

1. A written suppliers warranty shall be provided for the equipment specified in this section as required in Section 11.2, General Conditions.

1.5 MANUFACTURERS SERVICE REPRESENTATIVE

A. Erection and Start-up Assistance: The CONTRACTOR shall require the manufacturer for each piece of equipment to provide the services of a trained, qualified factory service representative for not less than 2 days at the plant, to assist in the erection and start-up of the equipment.

B. Instruction of OWNER's Personnel: In addition to the above services the CONTRACTOR shall include one full working day at the plant, for each piece of equipment, for a qualified factory representative, to inspect the finished installation and instruct the OWNER's operating personnel.

PART 2 PRODUCTS

2.1 EQUIPMENT

A. General: Each item of equipment shall be furnished and installed complete with all supports, electric drive units, sludge collector, mechanical equipment, electrical work and appurtenances ready for operation. All mechanisms or parts shall be amply proportioned for the stresses which may occur during operation or for any other stresses which may occur during fabrication and erection. Guards shall be furnished for all exposed moving shafts, drives, or parts as required by the applicable safety codes. All main drive assemblies shall be provided by the equipment manufacturer.

B. Power Supply: Power supply to the equipment shall be 480-volt, 60-Hz, 3-phase, unless otherwise specified.

C. Workmanship: Sharp corners of cut or sheared edges which will be submerged in operation shall be dulled by at least one pass of a power grinder to improve paint adherence. Welds on submerged surfaces and edges shall be of the continuous type.

D. Overload Protection: Each equipment drive mechanism shall be supplied with an automatic overload protection device of the mechanical type, in a stainless steel or cast aluminum weatherproof housing. Gray cast iron housings, coated in conformance with Section 09900, Paintings and Coatings, will also be accepted. The device shall incorporate the worm thrust bearing which shall allow the worm shaft to move axially.

E. The mechanical overload device shall be designed to resist the maximum thrust from the worm shaft and shall have means to indicate the load on the mechanism at all times. The overload indicator shall be oriented so that it may be easily read from the walkway.

F. Switches in a NEMA-4 weatherproof enclosure shall be provided to actuate an alarm at 85 percent of maximum continuous running torque and to shut down the motor at the maximum continuous running torque. These switches shall be accurately factory calibrated as noted above, and rated for twice the maximum continuous running torque.

2.2 MATERIALS

A. General: All materials used shall be suitable for service in a moist, corrosive environment, as encountered in water and wastewater treatment plants.

B. Plates and Structural Members: Except where otherwise specified or shown, all plates and structural members designed for submerged service shall have a minimum thickness of 1/4-inch.

C. Bolts and Nuts: All bolts, nuts, anchor bolts, and washers shall be of Type 316 stainless steel, in accordance with Section 05500, Miscellaneous Metal, as specified for submerged service; they shall be of high strength and sized for the intended purpose. All bolt heads and nuts shall be hexagonal. Anchor bolts shall be cast-in-place in new concrete.

2.3 TANK BOTTOM GROUTING

A. For circular clarifiers, the completed sludge collector unit(s) shall be of sufficient structural and mechanical strength to sweep in the 2-inch grout on the tank bottom under its own power. The grout shall be in accordance with Section 03600 Grout and as recommended by the Manufacturer. Surface preparation of the cured concrete slab shall be performed to ensure adhesion of the grout to the concrete slab.

PART 3 EXECUTION

3.1 GENERAL

A. The equipment shall be fabricated, erected, assembled, and placed in proper operating condition in full conformity with the drawings, specifications, engineering data, instructions, and recommendations of the equipment manufacturer as accepted by the ENGINEER. All units shall be lubricated in strict accordance with the manufacturer's instructions

B. All ferrous metals shall be painted in accordance with the Section 09900, Paintings and Coatings

3.2 FINAL ADJUSTMENT

A. The CONTRACTOR shall obtain the services of a qualified factory service representative to perform all final adjustments and checking of the equipment in accordance with the Specifications.

3.3 ACCEPTANCE TESTS

A. After installation of the equipment and after completion of the services of the manufacturer's representative, and when plant influent is available, the CONTRACTOR shall operate each unit to demonstrate its ability to operate continuously without vibration, jamming, or overheating and to perform its specified functions satisfactorily.

B. Any defects shall be corrected promptly, or defective equipment replaced.

C. All final adjustments necessary to place the equipment in satisfactory working order, including leveling of the weir with reference to the liquid in the tank, shall be made at the time of the above test.

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SECTION 11231 – CIRCULAR, CENTER-FEED CLARIFIER

PART 1 GENERAL

1.1 THE REQUIREMENT

A. The CONTRACTOR shall furnish and install one (1) secondary circular center-feed clarifier consisting of sludge collector and skimming equipment, complete and operable, in accordance with the Contract Documents.

B. The equipment furnished for each clarifier mechanism shall include the walkway bridge with handrails, center assembly with drive unit, drive control, stationary influent column with upper inlet openings, influent feedwell, flocculation well, center cage, sludge removal arms with blades and squeegees, hopper for RAS withdrawal pipe, scum skimmer arms, scum box, weirs, baffles, and anchor bolts, and all other appurtenances required or shown.

1.2 REFERENCE SPECIFICATIONS, CODES, AND STANDARDS

A. Commercial Standards: Refer to Section 11230 for applicable Commercial Standards.

1.3 CONTRACTOR SUBMITTALS

A. General: CONTRACTOR shall submit administrative, shop drawings, samples, quality control, and contract closeout submittals of all equipment furnished in this Section and in referenced Sections. The shop drawing submittal shall include but not be limited to the following details:

1. Anchor bolt placement measured from construction joints in the concrete structure. Anchor bolt details shall include projections from concrete.

2. Type and size of structural details, and all pipe connection details.

3. Walkway construction details and dead load deflection computations.

4. Skimming device details.

5. Type, specifications, details, input and output speeds, exact gear ratios, service factor (24-hour continuous service), capacity, and efficiency of gear reducer units and drive assembly. Diameter of ball race.

6. Size, make, and type designation of electric motor, including mounting details.

B. Shop Drawings and Samples: Shop drawings and samples shall be submitted in accordance with the requirements of Section 01340 Shop Drawings, Product Data and Samples.

C. O & M Manuals: The CONTRACTOR shall provide operators and maintenance data for all equipment furnished for the project in accordance with Section 01730, Operation and Maintenance Data.

D. Tools: Special tools necessary for maintenance and repair of the equipment shall be furnished as a part of the WORK hereunder; such tools shall be suitably stored in metal tool boxes, and identified with the equipment number by means of stainless steel or solid plastic name tags attached to the box.

E. CONTRACTOR shall submit the Manufacturer's calculations substantiating the output torque rating of the complete drive mechanism, including gears and pinions. The calculations shall clearly specify the values used for the following design parameters for surface durability and strength ratings:

1. Number of Pinions

2. Actual Face Width

3. Tooth Geometry Factor (I & J Factors)

4. Load Distribution Factor

   a. The load distribution factor shall be determined as described in the referenced AGMA standard under Section 11230, Clarifiers /Sedimentation Tanks, General. The net face width for surface durability calculations shall not exceed 90 percent of the actual face width of the narrowest of the two mating gears. For parameters which are material dependent, such as allowable contact stress, the calculations shall include a full description of the materials and heat treatments used.

5. Allowable Contact Stress

6. Allowable Bending Stress

7. Pinion Pitch Diameter

8. Tooth Diameter Pitch

9. Hardness Ratio Factor

10. Elastic Coefficient

11. Life Factor

12. Worm and Worm Gear Pitch Diameter

13. Worm Gear Effective Face Width

14. Worm Thread Lead Angle at Mean Diameter

15. Worm Thread Normal Pressure Angle

16. Worm Sliding Velocity

17. Mean Worm Diameter

18. Worm and Worm Gear Service Factor (1.25 min.)

19. Worm and Worm Gear Materials Factor

20. Worm and Worm Gear Overall Speed Reduction Efficiency

1.4 QUALITY ASSURANCE

A. CONTRACTOR shall submit the following:

1. MANUFACTURER's Certificate of Proper Installation

2. Functional Test Certification

3. Factory performance test reports

4. Special shipping, storage and protection, and handling instructions

5. MANUFACTURER's printed installation instructions

6. List of suggested spare parts to maintain the equipment in service for a period of 5 years. Include a list of special tools required for checking, testing, parts replacement, and maintenance.

7. List of special tools, materials, and supplies furnished with equipment for use prior to and during startup.

B. Warranty

1. A written suppliers warranty shall be provided for the equipment specified in this section as required in Section 11.2, General Conditions.

C. Drivehead Torque Definition: The drivehead torque shall be defined as specified in Section 11230, Clarifiers/Sedimentation Tanks, General. The gear teeth shall not be stressed to more than allowed, according to the referenced AGMA Standard, at a load equivalent to a value of the momentary peak (stalled) torque. The entire mechanism shall be capable of withstanding an impact load of the momentary peak (stalled) torque, without sustaining damage or permanent deformation. The 20-year maximum continuous running torque shall be a computed value according to the referenced AGMA standard under Section 11230, Clarifiers/Sedimentation Tanks, General.

1.5 MANUFACTURERS SERVICE REPRESENTATIVE

A. Manufacturer's Representative. In accordance with the requirements of Section 01660, a Manufacturer's Representative shall be present at the site or classroom designated by the OWNER to provide the services and minimum person-days listed below, travel time excluded.

1. 2 person-days for installation assistance and inspection,

2. 1 person-days for functional and performance testing

3. 1 person-days for pre-startup training of OWNER's personnel.

PART 2 PRODUCTS

2.1 GENERAL

A. Each clarifier mechanism shall be of the center-drive type, supported on a stationary influent column, with the flow entering at the bottom of the influent column and flowing upward to the inlet openings near the water level. The clarifier shall be designed to remove the sludge uniformly from the bottom of the tank.

B. The equipment shall be designed for an operating speed of 2.6 revolutions per hour. The equipment shall be furnished with a drive system such that the maximum rake arm tip speed is 15 feet per minute.

C. Design Criteria

Description	Value
Equipment No.	34-ME-01-ML
Service	Secondary clarifier
Influent Flow (MGD)	Minimum: 1.0 Average: 5.0 Maximum: 10.0
RAS Flow (MGD)	Minimum: 1.25 Average: 3.4 Maximum: 7.0
Overflow (gpd/sf)	Minimum: 120 Average: 296 Maximum: 592
Tank Diameter (ft)	110
Side Water Depth (ft)	14
Freeboard (in)	18
Bottom slope (in/lf)	1
Walkway, width (ft)	4
Influent Column, dia (in)	30
Effluent Pipe, dia (in)	27
RAS Pipe Outlet, dia (in)	14
Scum drain, dia (in)	6
Influent Well, dia (ft)	12

Influent Well, depth (ft)	5
Flocculation Well, dia (ft)	34
Flocculation Well Depth (ft)	8
Weir v-notch depth (in)	2
Scum baffle depth (in)	18
Motor, minimum (hp)	0.75
Motor (rpm)	1,800
Sludge Arm Tip speed, min (fpm)	14.50
Sludge Arm Tip speed, max (fpm)	15.0
Max continuous running torque (ft-lbs)	30,100
100% Duty rated torque (ft-lbs)	70,000
Momentary peak (stalled) torque (ft-lbs)	123,000
Minimum ball race dia (in)	45

2.2 DRIVEHEAD

A. Design Parameters: The drivehead shall be designed for the torque values listed above. It shall turn the mechanism at a speed of approximately 0.043 rpm. The drivehead bearings shall be designed for the total rotating weight with a minimum B-10 life of 20 years, or 175,000 hours, for continuous operation, if renewable liners are used. If no renewable liners are used, this value shall be increased to 50 years or 450,000 hours. The drivehead shall be capable to produce and withstand the above listed momentary peak (stalled) torque, while starting. The drivehead gear shall be designed to a minimum AGMA 5 Lead 8 rating when rated in accordance with AGMA 908-B and AGMA 2001-B. The maximum continuous running torque rating of the complete drive shall be based on the smaller of the two values determined from the above AGMA standard.

B. Physical Characteristics: The drivehead shall consist of a removable internal main gear, pinion, secondary worm gear set, support base, and drivehead bearing. The drivehead shall be mounted on the center column and support the entire rotating weight of the mechanism. The main internal gear shall be fabricated of alloy hardened steel or ductile iron (cast iron containing) primary graphite in nodular form). The main gear shall have a face depth to diameter ratio of 0.15 or greater for ductile iron and 0.07 or greater for alloy hardened steel. The pinion shall be heat treated alloy steel and forged integral with the shaft, or shall be alloyed nodular iron. The worm gear shall be of hardened alloy steel, meehanite, or centrifugally cast bronze. All gears shall be fully enclosed and running in oil. Support base for the drive shall be of cast iron, meehanite, or welded

steel, to assure rigidity. Oil and dust shields shall be provided. Seals shall contact a machined surface. The drivehead bearing shall include a hardened replaceable raceway, or it shall be a forged steel precision gear/bearing set, with fully contoured raceways. Raceway liners shall be either temperature drawn or bearing quality steel, heat-treated to minimum 40 Rc. An oil sight glass shall be provided for the upper and lower oil reservoirs. Balls shall be grade 500 and heat treated to 60 Rc. Readily accessible lubricant fill and drain pipes with necessary fittings shall be provided.

C. Overload Protection: The overload device shall be provided in a weatherproof, NEMA 4, enclosure as specified in Section 11230, Clarifiers/Sedimentation Tanks, General. The device shall be actuated by thrust from the worm shaft or rotation of the secondary gear reducer, which shall operate 2 switches (the alarm switch at 85 percent of maximum continuous running torque and the motor cutout switch at 100 percent of maximum continuous running torque). These 2 switches shall be factory adjusted to accurately calibrate the alarm torque value and the overload position. A visual torque dial indication shall be provided and oriented so that it may be read from the walkway. It shall be calibrated from 0 to 100 percent of 100% Duty rated torque. The secondary housing may not be allowed to rotate or have exposed linkage rods or bars to activate the torque device.

D. Turntable: The turntable base shall have an annular raceway for a ball race upon which the rotating assembly rests. It shall have a maximum allowable deflection of 0.024 inches with an allowable modulus of elasticity of 25 x 106 psi when fabricated from steel and 17 x 106 psi when cast iron. The center cage and sludge collection arms shall be fastened to and hung from the gear casing. Ball bearings shall be of the finest quality high carbon, chrome alloy steel balls running in renewable heat-treated alloy steel races mounted in the turntable base and in the gear casting, or in fully contoured races, as part of a precision gear bearing set. The balls shall run in an oil bath which shall be protected by a felt seal and steel dust shield. The oil baths shall be provided with a fill pipe, plug, sight gage indicator, and drain plug.

E. Speed Reducing Unit: The worm gear shall in turn be driven by a vertical chain drive or direct connection from a gear motor or worm or helical gear speed reducing unit made to AGMA standards and bearing the AGMA nameplate. The speed reducing unit shall have a service factor of 1.25. There shall be no overhung pinions without lower bearings.
The lower pinion bearing shall not be located at an elevation below the turntable base. The pinion shall be one piece extending through the upper and lower bearings of the two housings (worm gear and main gear) or keyed to the pinion shaft. A cycloidal - type drive unit shall not be an acceptable alternate to the specified worm gear drive.

F. Motor: The motor shall be a 1800 rpm synchronous speed, squirrel cage, induction type, totally enclosed, ball bearing heavy duty unit of ample power for starting and operating the mechanism without overload, with a service factor of 1.0, all in accordance with Section 16220, Low Voltage Motors. The motor shall be not less than 0.75 hp and the connected load shall' not exceed 85 percent of the motor nameplate horsepower rating under any anticipated operating condition.

G. Spare Parts: Each size and type of clarifier drive supplied shall be furnished with the following spare parts:

Description	Number

Bearings	1 set
Gaskets and oil seals	1 set
Lubricants	1 year supply

2.3 WALKWAY AND PLATFORM

A. Access Walkway: The clarifier shall be provided with a walkway consisting of rigidly interlaced structural steel beam members or of structural truss construction, connecting the drive platform to the access stairs. The 48-inch wide walkway shall be fabricated of aluminum safety grating. Grating shall be in accordance with the requirements of Section 05500, Miscellaneous Metals. Aluminum handrails, in accordance with Section 05520 Aluminum Handrails and Guardrails, shall be installed around the center drive platform and on both sides of the walkway or a structural truss system may serve as walkway handrail as approved. Walkway and handrails shall meet OSHA standards. A 4-inch by 1/4-inch aluminum toe board shall be provided. If a structural truss system is supplied, additional rails may be required to meet safety codes. Access walkway flooring and stairs shall be 1-1/2-inch aluminum bar grating, attached between the channels, including aluminum stringers and stainless steel bolts. All aluminum in contact with other metal or concrete shall be painted in accordance with Section 09900, Paintings and Coatings.

B. Walkway Support: The walkway shall be supported by the exterior wall and the drivehead casing which, in turn, shall be supported by the center column. The walkway shall be designed to safely withstand a live load of 150 lb/linear foot, plus dead load, with a deflection of not more than 1/360th of the span. Maximum dead load deflection shall be 0.5 inches, Necessary provisions shall be made for expansion and contraction of the walkway.

C. Center Drive Platform: A center drive platform shall provide access to the center assembly and drive control. It shall consist of 1-1/2-inch aluminum bar grating, with necessary stiffeners and supports, resting on the center assembly, be provided with connections to the walkway, and be provided with an access hatch over the drive oil drain. The entire platform shall be surrounded by handrails in accordance with Section 05520, Aluminum Guardrails and Handrails. To meet the electrical code, the center platform shall provide not less than 3.5 feet of working clearance around the drive unit and all auxiliary equipment shown on Contract Documents, including hose bib and rack.

2.4 INFLUENT

A. Stationary Influent Column: A cylindrical 30-inch minimum diameter steel center column shall be provided to support the drive, collector mechanism, and walkway. The top of the column shall have a drive mechanism mounting plate which shall be set plumb with the centerline. The drive unit shall be positioned and leveled prior to the center column being grouted in place. The column shall be fabricated of minimum 3/8-inch thick steel plate with supporting flange, anchored to the concrete base with a minimum of twelve 1-1/2-inch diameter stainless steel anchor bolts. The CONTRACTOR shall obtain information from the equipment manufacturer to accurately locate these anchor bolts. The structure shall provide adequate support for the entire mechanism plus live load torque, with an adequate factor of safety to eliminate excess deflection or vibration. A minimum opening area of 7 sq ft shall be provided in the upper portion of the column to allow unrestricted passage of the flow into the influent well.

B. Influent Feedwell

1. A rotating energy dissipating type influent feedwell shall be supported by the center cage to diffuse the liquid into the basin without disturbance or formation of density currents. The feedwell shall be of the influent distribution type and shall be designed to positively prevent sludge deposits in the feedwell. Openings shall be provided to allow the scum to exit the feedwell. Elevations of these openings shall be coordinated with weir elevations to allow scum to exit feedwell at all flow rates.

2. The influent feedwell shall consist of a central rotating well equipped with multiple tangential control gates or deflector plates, to give equal diffusion of flow into an outer flocculation well. The configuration of these gates shall be as shown on the drawings. The central rotating feed well shall be not less than 12 feet in diameter and 5 foot submergence and shall have a minimum of 8 control gates. The influent feedwell shall be made of not less than 3/16-inch thick steel plate with necessary stiffening angles and stainless steel supporting brackets.

C. Flocculation Well: The diameter of the outer rotating flocculation well shall not be less than 34 feet and the submergence shall not be less than 7 feet 7-1/4 inches. The flocculation well shall be made of not less than 3/16-inch thick steel plate with necessary stiffening angles and stainless steel supporting brackets. Reinforced fiber glass with ultraviolet protection and stainless steel fasteners may be used in place of steel plate. A minimum of 8 baffled openings shall be provided in the flocculation well to allow scum to escape.

D. Center Cage: The center cage shall be of steel box truss construction. It shall be provided with connections for the 4 sludge removal arms, feedwell supports, and flocculation well supports. The cage top shall be bolted to the main gear which shall rotate the cage with the attached arms and feedwell. The cage and arms shall be designed to withstand twice the maximum continuous running torque of the drive without overstressing the members.

2.5 SLUDGE REMOVAL ARMS

A. The clarifier mechanism shall include two (2) full radius sludge removal arms and two (2) 20 foot radius stub arms of steel truss construction, a minimum of 3’-10 square with steel ranking blades and adjustable 20 gauge 304 stainless steel squeegees. The squeegees shall project 1-1/2 inches below the bottom of the rake blades.

B. The truss members and rake blades shall be of adequate size to withstand twice the continuous running torque and be capable of raking any normal sludge deposit encountered without distorting the truss arms or the center cage. If rectangular box construction is used, there shall exist bracing in each and every bay where the truss members meet. If members are placed back to back, there shall be a space between them of at least 1/2-inch; this is required to accomplish the work of cleaning and painting.

2.6 SKIMMER

A. The CONTRACTOR shall furnish and install skimming devices as part of the clarifier mechanisms. Each mechanism shall be furnished with two skimming arms which shall be arranged to sweep the surface of the sedimentation compartment, automatically removing scum and floating material into a scum box at the periphery of the tank.

B. The skimming system shall be designed, constructed, and installed to effectively capture and remove scum. Once installed, the system shall be tested and adjusted to provide proper operation. The system shall operate without jerking or losing the accumulated scum. Any modifications to the skimmer, scum box, scum scraper or anti-rotational baffle required to obtain proper operation shall be performed by the CONTRACTOR at no additional cost to the OWNER.

C. Skimmer Construction

1. The rotating skimmers shall consist of a continuous skimming blade extending from the center flocculation well towards the tank periphery. At the end of each skimmer blade, a hinged scum scraper with neoprene wipers shall be provided to remove scum and deposit in the scum box. The skimmers shall be supported and driven from the full diameter rake arms by A-frame or other rigid supports.

2. The skimmer blades shall be constructed using a vertical steel plate, reinforced as necessary to ensure adequate stiffness to maintain contact with the stationary anti-rotational baffle attached to the walkway. The skimmer blades shall be attached to the rake arms and shall be oriented so that the interior end is essentially tangent to the flocculation well. The skimmer blades shall angle back from the outside of the flocculation well to the center of the rake arm to provide a scissoring action between the skimmer blade and the anti-rotational baffle to force the scum to the tank periphery.

D. Scum Box

1. The scum box shall be supported from the tank wall and shall be connected to the scum sump by a 6-inch diameter scum pipe. The scum box shall be made of steel plate and shall serve as an integral section of the tank's scum baffle. The scum box shall be 6'-0" wide.

2. The assembly shall have vertical steel sides, an approach ramp, flat scum accumulation area at least 2'-6" long, sloping beach, scum trough and exit ramp. The scum box design and location shall ensure that the scum on the surface of the tank is captured by the skimmer blade and conveyed by the scissoring action of the anti-rotational baffle to the scum box without losing the accumulated scum. The scum box shall be designed so that the skimmer smoothly enters the scum box, traps the scum in the accumulation area, and lifts the scum up the beach and into the scum trough without jerking or losing the accumulated scum. The exit ramp shall provide a smooth return of the skimmer to its normal operational position.

3. A 6-inch flanged outlet shall be provided on the scum box for the scum discharge pipe. A 6-inch diameter pipe and flexible connector shall be provided to connect the scum box to the scum outlet pipe in the tank wall.

E. Scum Scraper

1. The scum scraper shall consist of a hinged scraper assembly mounted on the outer end of the skimmer. The scum scraper shall maintain contact with the scum baffle as it travels around the tank periphery. The hinged scraper assembly shall be designed to form a pocket at least 2'-6" deep by 6'-0" wide for trapping the scum. The hinged scraper shall be designed, constructed, and installed to ensure continual contact and proper alignment between the wiper blade, scum baffle and

scum box so that the scum is effectively collected and conveyed up the beach to the scum trough without jerking or losing the accumulated scum.

2. The hinged scraper shall be counter weighted to provide adjustment. Spring-operated mechanisms are not acceptable. The scraper shall be' equipped with adjustable neoprene wiper blades on the bottom and ends of the scraper blade. The neoprene wipers shall be continuous and shall be of sufficient stiffness to maintain contact with the scum box and scum baffle and prevent loss of scum. The neoprene shall be at least 3/8-inch thick and shall be installed with minimum projection from the steel scraper blade.

F. Anti-Rotational Baffle: The anti-rotational baffle shall be attached to the walkway as shown on the Drawings. The baffle shall have sufficient stiffness and shall be mounted in such a manner that the scum is "scissored" between the baffle and the skimmer and is conveyed to the tank periphery for removal at the scum box. The baffle shall be continuous and shall maintain contact with the skimmer as it passes the walkway to ensure that the scum is conveyed to the scum box and is not lost.

2.7 ALGAE SWEEPS

A. General. Algae sweeps shall be provided on each skimming arm on each clarifier and shall be supported from the support tubes of the skimming arms. Algae sweeps shall utilize brushes to clean both sides of the weirs, both sides of the baffle and all concrete effluent surfaces of the launder and the outboard side of the effluent weir scum baffle. All metallic parts of the system shall be constructed of Type 304 stainless steel. The system shall be constructed to avoid any noticeable torque increases and shall be capable of encountering an indefinite stall without incurring damage. The unit shall be designed with an engaged position for cleaning, and a disengaged position allowing the system to ride idle around the tank. Each algae sweep shall be divided in half. With half being installed on each skimmer arm.

B. Attachment Assembly: The attachment assembly shall provide a means of attaching the algae sweep system to the skimmer arm so as not to interfere with any other operations of the skimmer arm.

C. Mainframe. The mainframe shall be constructed of Type 304 stainless steel and designed to slip easily into the attachment assembly and be tightened in position with the use of set screws. The mainframe shall be designed so that the brush arms can be positioned at any point on the mainframe.

D. Brush arms. All brush arms shall be of Type 304 stainless steel and custom designed and installed to allow for cleaning all specified surfaces and to allow for the following:

1. Flexibility to clean effluent surfaces within a plus or minus 4-inch radial variance.

2. To allow brush holder to be adjusted telescopically so that a maximum number of brush arm adjustments are possible.

3. To have opposite the mainframe end, a brush holder attachment allowing for the insertion of a brush.

4. To have a means of biasing the arm to the mainframe so as to provide sufficient force to remove algae and debris.

E. Brushes

1. Brushes shall be provided that slip easily into the brush holder and provide the cleaning means necessary to remove algae and debris from their respective surfaces.

2. Brush construction shall be durable plastic able to withstand continuous exposure to sunlight, seasonal temperature changes and the corrosive elements found in wastewater. Brush bristles shall be polypropylene with adequate trim length, density, and stiffness for extended continuous use. Brushes shall be cut and shaped appropriately so as to clean their respective surfaces without binding.

F. Brush Bridge: A bridging device shall be provided and positioned over the effluent discharge hole to support the channel brush assembly. The bridge shall be constructed entirely of Type 304 stainless steel.

G. Algae sweeps shall be provided by the MANUFACTURER.

1. All equipment components of the algae sweeps including the attachment assembly, mainframe, brush arms, brushes, brush bridge, and all other appurtenances required or shown shall be furnished by Ford Hall Company, Inc to match existing.

2.8 EFFLUENT WEIR, SCUM BAFFLE, AND DENSITY CURRENT BAFFLE

A. Scum Baffles: The scum baffles shall consist of curved sections of 1/4-inch thick by 18-inch deep fiber glass plate attached to the tank wall by fiber glass brackets, stainless steel anchor bolts and hex nuts, to enable 1-inch vertical and sufficient radial adjustment to keep baffles round and always in contact with the scum skimmer. The baffle shall be stiffened as required, using rolled steel angles, to maintain the baffle in the proper position and prevent flexing.

B. Effluent Weirs: The effluent weirs shall consist of 1/4-inch thick by 9-inch deep fiber glass plate sections with 2-inch deep 90 degree V-notches at 6-inch intervals. The weir sections shall be curved and fastened to the tank wall with washers, clamps, stainless steel anchor bolts and hex nuts to allow vertical adjustment.

C. Density Current Baffle

1. The density current baffle system shall be provided by the Manufacturer and consist of a series of baffle panels which are attached to the inboard launder and from an inclined at a minimum angle of 90 degrees, shelf-like surface around the entire inner periphery of the tank as indicated on the Drawings.

2. Glass reinforcement to consist of chemically bonded surfacing mat and copped strand roving, with the glass contents of the finished laminate to be not less than 30 percent by weight.

3. The nominal thickness of each baffle panel shall be 1/4 inches minimum.

4. Attach the panels to the inboard launder at a reinforced mounting flange and support them at the proper angle with a triangular shaped bracket. The brackets shall be fabricated of Type 316 stainless steel.

5. Design the baffle to withstand a buoyant force load equal to the weight of the water displaced from the volume beneath the baffle. In addition, design the baffle to withstand wind loads per Specification 01614, Wind Design Criteria. Provide sufficient pitch and width of the angle's working surface of the baffle to divert the flow and create a self cleaning action of the baffle.

6. Include provisions to vent gases which may form beneath the baffle through the installation of vents located in the panel.

7. Manufacturer shall also furnish certified design calculations and drawings showing details of installation.

8. Install the baffle as indicated on the Drawings and in accordance with the MANUFACTURER's recommendation. For attachment of the baffle panels, use concrete expansion anchors with neoprene-backed fender washers, lock washers and hex nuts. Use Type 316 Stainless steel for all the installation fasteners.

2.9 APPURTENANCES

A. High Torque Alarm Light: Manufacturer shall provide a 120 volt, weatherproof, 60 watt, high torque alarm light mounted on center platform of clarifier.

B. Scum Box Spray Switch: A limit switch is to be provided by the MANUFACTURER to activate a solenoid valve and scum trough spray system as the skimmer arm approaches.

2.10 CONTROLS

A. Pump controls shall be supplied per Section 13421, Programmable Logic Controllers and Computer Control Systems.

2.11 PROTECTIVE COATING

A. Materials and equipment shall be coated in accordance with Section 09900 Painting and Coatings and the Contract Documents.

2.12 MATERIALS OF CONSTRUCTION

A. All submerged and non-submerged fabricated steel shall be 304 SS or 304L SS.

B. All stainless steel shall be cleaned and passivated per ASTM A380.

C. All fabricated stainless steel surfaces (except machined surfaces) shall be abrasive blast cleaned with maximum 80 mesh size sand that has been certified clean and free of ferrous materials, to a uniform finish and until all heat tint and embedded iron are removed. Blasting shall be followed by testing for embedded or free iron by spraying the stainless steel with phosphoric acid. Twenty-four (24) hours after spraying the stainless steel shall be rinsed with water containing a maximum total solid content of 200 ppm and allowed to dry. Any signs of iron contamination after the stainless steel is dry shall require the phosphoric acid spraying and rinsing to be repeated until a chemically clean passive finished surface is obtained.

2.13 MANUFACTURERS

A. MANUFACTURER's Experience: The materials and equipment covered by this specification are intended to be standard materials and equipment of demonstrated successful performance and supplied by a manufacturer who has been actively engaged in the supply of similarly sized clarifier mechanisms for a minimum of 20 years. Equipment shall be designed and constructed in accordance with the highest standards of the industry and shall be installed in accordance with the MANUFACTURER's recommendations and the Contract Documents.

B. Unit Responsibility: All equipment components of the clarifier mechanism including the walkway bridge with handrails, center assembly with drive unit, drive control, stationary influent column with upper inlet openings, influent feedwell, flocculation well, center cage, sludge removal arms with blades and squeegees, hopper for RAS withdrawal pipe, scum skimmer arms, scum box, weirs, baffles, and anchor bolts, and all other appurtenances required or shown shall be furnished by the same MANUFACTURER.

C. Manufacturers, No Equal (match existing):

1. Ovivo (EIMCO).

PART 3 EXECUTION

3.1 DELIVERY AND STORAGE

A. A complete set of MANUFACTURER's instructions covering storage, installation, operation, lubrication, and maintenance shall be furnished to the OWNER no later than the date the equipment is shipped. Care during storage and procedures for installation, lubrication, and startup of the equipment and motors shall be in strict conformance with the MANUFACTURER's instructions.

3.2 INSTALLATION

A. Install in accordance with the MANUFACTURER's printed instructions.

3.3 GROUTING THE TANK FLOOR

A. After the equipment has been erected, a 2-inch layer of grout shall be applied to the tank floor, using screeds installed on the mechanism rake arms to form the finished surface. Grouting shall not be done until the mechanism has been inspected by the Manufacturer. Preparation of the base slab surface shall be accepted by the ENGINEER prior to grouting. Grouting procedure and the grout mix shall be as recommended by the Manufacturer, in accordance with Section 03600, Grout, and as accepted by the ENGINEER. The grout mix shall be sand and cement, and in no event shall the mix contain aggregate.

3.4 TESTING

A. Testing shall be conducted in accordance with Section 01660, Testing and Training, and Section 11000, Equipment General Provisions.

B. Field Testing

1. Each clarifier mechanism and alarm system shall be dynamically field torque tested to 100 percent of the specified maximum continuous running torque and shall be statically field torque tested at twice the continuous running torque. Each mechanism shall be tested in the presence of the ENGINEER and Manufacturer by applying the load evenly to each of the two full diameter arms, before the mechanism is accepted and placed into operation.

2. The dynamic test shall be performed on the clarifier mechanism to verify accurate torque indication and adequacy of the mechanism to safely withstand the specified maximum continuous running torque. The test shall accurately depict actual operation of the mechanism and shall not apply impact loading, jerky loading, or abnormal conditions which may reduce the life of the equipment.

C. A torque test device shall be attached near the outer end of each rake arm. The device shall allow load to be gradually applied uniformly to each arm as the arm rotates. Readings of the load applied at the arm versus the torque indicator reading shall be taken at 100 pound increments until the specified cut out torque is achieved. This load shall be applied over not less than one half revolution of the mechanism.

1. The CONTRACTOR shall perform a static torque test on each mechanism after successful completion of the dynamic torque test. The testing shall be carried out under the supervision of the manufacturer with the approval of the ENGINEER before the mechanisms are placed into operation. The purpose of the test shall be to verify the structural integrity of the mechanism.

2. The static torque test shall consist of securing the rake arms by cables to anchor bolts installed by the CONTRACTOR in the tank floor at locations recommended by the Manufacturer. A torque load shall be applied evenly to the two full diameter rake arms by means of a ratchet lever and hydraulic cylinder connected to the cable assembly. The magnitude of the applied torque load shall be measured by a calibrated pressure reading and the distance of the line of action of each cylinder from the centerline of the mechanism. Readings shall be taken at 100 percent, 150 percent, and 200 percent of the maximum continuous running torque specified. Loads shall not be applied by turning on the motor.

3. Actual torque versus indicated torque shall be accurately indicated within 7 percent of full scale at all torque readings.

4. There shall be no permanent deformation of any component. If deformation does occur, or correct torque is not achieved, the defective parts shall be replaced by the CONTRACTOR and then retested at no cost to the OWNER.

END OF SECTION

SECTION 11450 – FINE BUBBLE PANEL DIFFUSER AERATION SYSTEM

PART 1 GENERAL

1.1 THE REQUIREMENT:

A. The CONTRACTOR shall furnish and install a fine bubble flexible membrane curved-linear panel diffuser system for the aeration basins as specified and shown in the Contract Documents.

B. All equipment shall be provided by a single MANUFACTURER, complete with accessories, connections, supports, safety equipment, and controls necessary for a workable system, in accordance with requirements of the Contract Documents.

C. The system shown on the Drawings is based on the supply of the first-named Supplier, Manufacturer, or Vendor. The Drawings show a general depiction of the equipment and indicate a level of accessibility and clearances that shall be required for installation and maintenance of the system components. The specific location of system connections and equipment may vary depending on the System Supplier. Additionally, the quantity and methods used for meeting the Contract requirements for safety may differ between what is provided by the System Suppliers and what is shown on the Contract Drawings. The supplied system shall fit within the footprints shown on the Drawings while maintaining the level of accessibility and clearances shown on the Drawings. If the Contractor selects a System Suppler other than the first-named System Supplier, Contractor shall be responsible for the cost of all modifications required to provide the accessibility and clearance requirements, and modifications required of equipment that are tailored to the specific system design at no additional cost to the Owner. Such changes to the layout shall not impair the equipment accessibility or limit maintenance access as generally indicated on the Drawings, nor shall it relieve the System Supplier's responsibility for meeting the requirements of the Contract Documents. Any re-design of structures, foundations, support utilities, or any other related infrastructure needed to accommodate other than the first-named supplier shall be borne by the Contractor, without additional cost to the Owner; any such re-design of related infrastructure shall be by the Owner's design engineer. Any costs associated with the Owner's design engineer evaluation of Contractor proposed alternate System Suppliers shall be borne by the Contractor.

1.2 REFERENCE CODES, AND STANDARDS

ASTM A 240	Heat-Resisting Chromium and Chromium-Nickel Stainless Steel Plate, and strip for Pressure Vessels
ASTM D 1784	Rigid Polyvinyl Chloride (PVC) Compounds and Chlorinated Polyvinyl Chloride (CPVC) Compounds
ASTM D 1785	Polyvinyl Chloride (PVC) Plastic Pipe, Schedules 40, 80, and 120
ASTM D 1869	Rubber Rings for Asbestos-Cement Pipe
ASTM D 2241	Polyvinyl Chloride (PVC) Pressure-Rated Pipe (SDR Series)
ASTM D 2466	Polyvinyl Chloride (PVC) Plastic Pipe and Fittings, Schedule 40
ASTM D 2564	Solvent Cements for Polyvinyl Chloride (PVC) Plastic Pipe and Fittings

ASTM D 2855 Practice for Making Solvent Cemented Joint with Polyvinyl Chloride (PVC) Pipe and Fittings

ASTM D 3034 Type PSM Polyvinyl Chloride (PVC) Sewer Pipes and Fittings

1.3 REFERENCE SPECIFICATIONS

1. Section 01340 – Shop drawings, Product Data, and Samples
2. Section 01660 – Testing and Training
3. Section 01730 - Operation and Maintenance Data
4. Section 01740 - Warranties and Bonds
5. Section 11000 – Equipment General Provisions
6. Section 11502 – Geared Single Stage Centrifugal Blower Packages.

1.4 DEFINITIONS

A. Tank or Basin: Reactor within which aeration occurs.

B. Diffuser Unit: Fabricated unit including diffuser support frame and flexible membrane which releases air to the water.

C. Diffuser Assembly: Fabricated assembly including two diffuser units and assembly mounting components.

D. Air Drop Pipe: Piping section from out-of-basin header stub to in-basin aeration system.

E. Air Manifold Piping: Air distribution piping from drop pipe to air distribution headers.

F. Air Header Distribution Piping: Air distribution piping from air manifold to diffuser assemblies.

G. Air Header Piping: Out-of-basin air distribution piping from the blower building to the header stubs.

H. Blower Manifold Piping: Air distribution piping between the blower discharge and air header piping.

I. Aeration Grid: Associated piping and diffuser components connected to a single drop pipe.

J. Standard Cubic Feet per Minute (scfm): Air at 20°C (68°F), 14.7 psia and 36% relative humidity.

K. Maximum Pressure: Pressure in blower manifold piping at the specified airflow rate.

L. Oxygen Transfer Efficiency: Percent of oxygen in the air stream that is dissolved to the wastewater under specified conditions of temperature, barometric pressure, airflow rate, and dissolved oxygen concentration.

M. Standard Oxygen Transfer Efficiency: Percent of oxygen in the air stream that is dissolved to clean water under conditions of 20°C (68°F), 14.7 psia, and zero dissolved oxygen.

N. Air Distribution Uniformity: Variation in air distribution between diffuser assemblies.

1.5 SYSTEM REQUIREMENTS

A. Design Requirements:

1. Design in-basin air piping and diffusers to diffuse air through the aeration tank(s) in accordance with the specifications.

2. Design each diffuser assembly to provide uniform air release over the specified airflow range.

3. Design the aeration system to provide the specified oxygen transfer efficiency at the specified airflow and operating pressure as minimum level of performance.

1.6 CONTRACTOR SUBMITTALS

A. General: CONTRACTOR shall submit administrative, shop drawings, samples, quality control, and contract closeout submittals of all equipment furnished in this Section and in referenced Sections in accordance with the requirements Section 01340 - Shop Drawings, Product Data and Samples.

B. Shop Drawings and Samples: In addition to the requirements of Section 01340 - Shop Drawings, Product Data and Samples, CONTRACTOR shall submit the following:

1. Descriptive literature and dimensional drawings for all equipment including, but not limited to, the air feed main, air distribution main, and diffuser assemblies indicating materials of construction, number, spacing, and location of diffusers, layout and size of air feed, and distribution mains.

2. Description and dimensional drawing showing the proposed method of supporting the air feed and distribution piping as required to prevent uncontrolled movement due to flotation and dynamic forces.

3. Descriptive literature and dimensional drawings showing the proposed method of compensation for thermal expansion and contraction in the aeration system.

4. Proposed method of draining water from the aeration system piping and all diffuser units when the aeration basins are full of liquid.

5. Design calculations showing oxygen transfer based on guaranteed performance.

6. Include complete air headloss calculations for the aeration equipment from the top of the dropleg to the farthest diffuser bubble release point.

7. Design calculations showing uniform air distribution (+10% maximum variation) through lateral piping and diffuser element orifice system.

8. Design calculations for piping and support components.

9. The recommended minimum design and maximum air flows per diffuser.

10. Head loss calculations for the air diffusers, flow control orifices, and system piping for the design airflow conditions specified.

11. A testing plan designed to ensure consistently good quality and uniformity of the diffuser assemblies, including a sampling plan.

12. A complete shop welding procedure for stainless steel pipe.

13. A curve showing the oxygen transfer efficiency of the proposed system at different air flow rates and densities in the design range (efficiency versus air flow rate at proposed depth).

14. A curve showing the change in oxygen transfer efficiency at the design flow rate over time. Data should extend to the recommended replacement life span.

15. Installation requirements and guidelines for all proposed equipment shall be provided.

16. Information on at least one successfully performing installation of comparable size and complexity constructed in the recent past, including contact name, telephone number, and address.

C. O & M Manuals: The CONTRACTOR shall provide operations and maintenance data for all equipment furnished for the project in accordance with Section 01730 - Operation and Maintenance Data.

1. Specific information on the aeration system shall include but not be limited to air flow balancing, diffuser assembly maintenance, and membrane replacement.

D. Tools: Special tools necessary for maintenance and repair of the equipment shall be furnished as a part of the WORK hereunder; such tools shall be suitably stored in metal tool boxes, and identified with the equipment number by means of stainless steel or solid plastic name tags attached to the box.

1.7 QUALITY ASSURANCE:

A. CONTRACTOR shall submit the following:

1. MANUFACTURER’s Certificate of Proper Installation

2. Functional Test Certification

3. Factory performance test reports

4. Special shipping, storage and protection, and handling instructions

5. MANUFACTURER’s printed installation instructions

6. List of suggested spare parts to maintain the equipment in service for a period of 5 years. Include a list of special tools required for checking, testing, parts replacement, and maintenance.

7. List of special tools, materials, and supplies furnished with equipment for use prior to and during startup.

B. Warranty

1. A written suppliers warranty shall be provided for the equipment specified in this section as required in Section 11.2, General Conditions.

1.8 MANUFACTURERS SERVICE REPRESENTATIVE

A. MANUFACTURER's Representative. In accordance with the requirements of Section 01660-Testing and Training, a MANUFACTURER's Representative shall be present at the site or classroom designated by the OWNER to provide the services and minimum person-days listed below, travel time excluded.

1. Two (2), eight-hour (8-hr.) days for each aeration train for installation assistance and final installation inspection

2. Three (3), eight-hour (8-hr.) days for each aeration train for functional testing, performance testing, adjustment and optimization of the aeration system valves and controls.

3. One (1), eight-hour (8-hr.) days for each aeration train for a factory representative, who has complete knowledge of proper operation and maintenance shall be provided to instruct representatives of the OWNER and ENGINEER on proper operation and maintenance, including pre-startup, start-up and shut-down procedures and troubleshooting of all equipment.

PART 2 PRODUCTS

2.1 GENERAL

A. The CONTRACTOR shall furnish, install and test the aeration diffuser systems for the aeration basins. For all systems that shall be furnished and installed, all necessary equipment and auxiliaries whether specifically mentioned in these Specifications or not, and as required for an installation incorporating the highest standards for the type of service. The piping system shall be in accordance with Division 15 and with the Piping Schedule shown, and it shall include all necessary fittings, supports, expansion joints, valves, and accessories.

B. The equipment specified in this Section, including drop pipes, header pipes, distribution pipes, air diffusers, and hold-downs, is for a complete aeration diffuser systems that will be installed in aeration basins.

C. System Configuration shall be in accordance with the Contract Drawings and the following:

No. of aeration zones	4 per each aeration basins

	/trains
No. of aeration basins	4
Dimension of each aeration zone (W ft x L ft)	Varies, refer to drawings
Water Depth each aeration zone (ft)	Varies slightly, refer to drawings

2.2 PERFORMANCE REQUIREMENTS

Design Total Oxygen Requirements (AOR) (lb O2/d)	33,757
Design Loading Split Between Aeration Basins	
Oxidation Ditch 1 (% of Design AOR)	33%
Zone 1E (% of OD1 AOR)	45%
Zone 1F (% of OD1 AOR)	25%
Zone 1G (% of OD1 AOR)	20%
Zone 1H (% of OD1 AOR)	10%
Oxidation Ditch 2 (% of Design AOR)	33%
Zone 2E (% of OD2 AOR)	45%
Zone 2F (% of OD2 AOR)	25%
Zone 2G (% of OD2 AOR)	20%
Zone 2H (% of OD2 AOR)	10%
Aeration Basin 3 (% of Design AOR)	17%
Zone 3E (% of AB3 AOR)	45%
Zone 3F (% of AB3 AOR)	25%
Zone 3G (% of AB3 AOR)	20%
Zone 3H (% of AB3 AOR)	10%
Aeration Basin 4 (% of Design AOR)	17%
Zone 4E (% of AB4 AOR)	45%
Zone 4F (% of AB4 AOR)	25%
Zone 4G (% of AB4 AOR)	20%
Zone 4H (% of AB4 AOR)	10%
Minimum Standard Oxygen Transfer Efficiency	30%
Minimum Standard Oxygen Transfer Efficiency per foot of depth	Defined by Manufacturer, 2 –

	2.25%
Top of diffusers from Basin Invert (ft)	1 Max
Max allowable pressure at the dropleg (psi)	7.2
Max Air Fluxrate (scfm/ft2)	2.6
Minimum Active Surface Area (ft2)	2.64
Minimum Mixing Requirement (scfm/ft2)	0.12
Max SCFM per aeration basin	Defined by Manufacturer
SCFM per diffuser	
Minimum	Defined by Manufacturer
Average	Defined by Manufacturer
Maximum	Defined by Manufacturer
Minimum Number of diffusers	Defined by Manufacture, varies by aeration zone in each aeration basin
Minimum number of diffusers per aeration basin	Defined by Manufacturer, varies by aeration zone in each aeration basin

A. Design Parameters:

1. General: The fine bubble diffused aeration system furnished under this section shall be designed to supply the aeration required to maintain a DO concentration of 2.0 mg/L in each aeration basin, and to maintain suspension of mixed liquor with an MLSS concentration ranging from 3,000 – 6,000 mg/L. The airflow rates to each basin will be varied independently to maintain the desired DO concentration in the mixed liquor.

2. Maximum available blower capacity at design is 3 duty blowers at 4,650 scfm each, total of 13,950 scfm. Refer to Specification 11502 – Geared Single Stage Centrifugal Blower Packages.

3. Differential pressure manometers with a gauge stanchion mounted shall be provided to measure headloss across the diffuser element at a minimum of 4 locations.

4. Active surface area shall be defined as the net perforated area of the media or membrane and shall reflect only that portion of the membrane which can be demonstrated to produce uniform air discharge under the full operating range proposed for the diffuser.

2.3 AERATION EQUIPMENT

A. MATERIALS

1. Welded Stainless Steel Components:

   a. Sheets and plates of Type 304L stainless steel conforming to AISI 304L and ASTM A240.

   b. Limit carbon content to 0.30% maximum.

2. Non-welded Stainless Steel Components:

   a. Sheets and plates of Type 304 stainless steel conforming to AISI 304 and ASTM A240.

3. Fasteners and Anchorage Components:

   a. 18-8 series stainless steel.

4. PVC Pipe and Fittings (Schedule 40 and 80 and/or SR 26):

   a. Base material shall be ASTM D-1784.

   b. Pipe shall be manufactured in accordance with ASTM D-1785 and ASTM D-2665.

B. Flexible Membrane, Fine Pore Diffusers:

1. The diffuser assembly shall be furnished by the MANUFACTURER and installed by the CONTRACTOR.

2. Each diffuser assembly shall be factory assembled and include two diffuser units and mounting saddle.

3. Diffusers unit shall have nominal dimensions of 4.5 inches in diameter and 53.5 inches long.

4. The diffuser membrane shall be fully supported over full length and circumference with a 4.5 inch PVC membrane support frame.

   a. Use of a non-fully supported diffuser membrane is not acceptable.

5. The diffuser support frame shall be approximately 53.5 inches long and have a full diameter mounting connection.

   a. Use of non-full diameter mechanical connections including threaded connections is not acceptable.

6. The diffuser membrane shall be held in place by two 304 stainless clamps.

    a. Retainer clamps shall be crimp type. Worm gear type clamps are not acceptable.

7. Installation of the diffuser membrane shall be accomplished with the removal and installation of the membrane clamps.

    a. Disassembly of diffuser assembly to remove and install membranes is not acceptable.

8. Individual diffuser units shall be provided with an internal end cap.

9. The diffuser unit shall be fully capable of operating under continuous or intermittent conditions and shall be designed with check valve capabilities to prevent entry of mixed liquor into the diffuser unit or air piping on air shutdown or interruption of air supply. A minimum of three (3) check valve features shall be provided, not limited to the following:

    a. Membrane shall be elastic and allow openings to close when the air supply is interrupted.

    b. Membrane shall contract and close around full diameter support frame.

    c. Membrane shall employ a non-perforated section that is aligned and seals against the support frame, air distribution orifices.

    d. Use of independent or internal check valve components is not acceptable.

10. Diffuser assemblies shall be completely factory assembled with diffuser units, membranes and mounting saddle factory installed.

    a. Field solvent welding or assembly of diffuser is not acceptable.

11. Diffuser assemblies shall be shipped to the jobsite assembled and properly crated and protected for shipment and handling.

12. Diffuser saddle mounts:

    a. Small diameter threaded connections to attach diffusers to the air distribution header are not acceptable.

    b. Saddle mount shall fully encompass the air distribution header and reinforce the pipe section at the diffuser assembly connection.

    c. Alignment plug shall be provided to ensure proper alignment and resistance to rotation.

    d. An O-ring gasket shall be provided to ensure an air tight seal between the mounting saddle and air header.

13. Panel diffuser units must be designed to allow independent adjustment of elevation of diffuser tips with respect to saddle elevation by adjustment of saddle

installation. Systems that cannot adjust elevation of diffuser tips independent of air supply piping of saddle mount shall not be acceptable..

14. Units shall be saddle mounted and suitable for field removal/installation without disturbing air supply piping. Systems with diffusers solvent welded to the air piping shall not be allowed.

15. Only panel diffuser systems demonstrating full ability to purge liquid/solids from the piping shall be considered.

    a. A minimum of one purge line and valve assembly shall be provided per dropleg pipe.

    b. Purge line shall be sized per the Manufacturer's requirements but shall be a minimum of ¾".

    c. Purge line shall be secured to the dropleg pipe.

    d. Purge valve assembly shall be hard-piped and installed and secured above the walkway elevation and accessible for operations and maintenance.

16. The diffusers shall not exceed the following:

    a. Maximum air Fluxrate = 2.5 scfm/ft2 (Nm3/m2) of active diffuser surface area at the design airflow.

    b. Active Surface Area = 3.52 ft2 minimum per diffuser arm.

    c. Active surface area shall be defined as the net perforated area of the media or membrane and shall reflect only that portion of the membrane which can be demonstrated to produce uniform air discharge under the full operating range proposed for the diffuser

C. Flexible Membrane:

1. Membrane material for the diffuser unit shall be dual layer PTFE embedded polyurethane. Alternate membrane materials are not acceptable unless specifically requested as a Bid Alternate.

2. Membrane shall be extruded in a single piece with the following characteristics.

    a. Membrane shall be 117 mm inside diameter with an overall length of 1359 mm.

    b. Perforated length on diffuser membrane shall be 1308 mm.

    c. Membrane shall be perforated on the top half of the sleeve.

    d. Non-perforated membrane section shall be provided to seal off air distribution orifices on the diffuser support structure.

3. Membrane shall be low pressure operation. Maximum pressure loss through membrane shall be less than 20 inches water column. Higher pressure membrane systems will be rejected.

4. Membrane must be constructed to allow easy field maintenance and field change. Systems with requirements to return diffusers to factory for membrane change shall be rejected. Stems that cannot demonstrate field change of a diffuser membrane by plant personnel in less than 2 minutes shall be rejected.

5. For long membrane life and low stress membrane shall be a tubular configuration with hoop stress benefits. Systems that use flat sheet membranes with edge clamps or bolts will be rejected.

D. Aeration System Piping:

1. Out-of-basin air piping including blower manifold, air header, and header stubs are required and are to be supplied by the Contractor.

   a. Header stubs shall extend to the inside top of the wall and terminate with a full diameter, horizontal face flange.

   b. Out-of-basin piping may be unlined ductile iron, galvanized steel, stainless steel, or painted carbon steel.

   c. The Contractor shall provide an isolating/balancing valve for control and distribution of air to the aeration grid and to allow isolating of the grid for inspection and maintenance on the header stub.

   d. Isolation/balancing valve shall be positioned for accessibility from the top of the tank.

2. Drop pipe shall be provided with a flanged top connection and plain end.

   a. Drop pipe shall extend from the top connection to within 2 feet of the air manifold.

   b. Material of construction for the drop pipe shall be schedule 5, 304 stainless steel.

   c. Drop pipe shall connect to air manifold piping by means of a wrap-around clamp adapter.

3. All submerged manifolds and header components shall be Schedule 40 PVC minimum.

   a. Use of PVC piping shall only be employed when the expected mean wall temperature is less than 140°C. If temperature exceeds this limit, alternate materials shall be used or cooling loops added until the temperature is at the appropriate level.

   b. Use of PVC piping shall only be employed when diffuser mounting system reinforces pipe wall at each mounting location.

c. Use of non-reinforced diffuser connections including threaded diffuser mounts is not acceptable.

4. Pipe supports shall be all stainless steel construction.

a. Supports shall accommodate longitudinal movement in the piping components due to the thermal expansion and contraction over a temperature range of 100°F.

b. Supports shall restrain the axial and rotational movement of the pipe while providing for unrestrained longitudinal movement.

c. Supports shall allow leveling of the air piping with 2 inch minimum vertical adjustment at each support.

d. Each pipe support shall be connected to basin floor by at least 2 anchor bolts.

e. The integrated pipe support assembly shall be designed to withstand the associated uplift force of the piping and diffuser assemblies with a minimum design factor of safety equal to ten (10).

f. Typical “Simple” pipe supports as referenced in the Drawings refer to supports designed to pivot at the base to allow for expansion and contraction.

g. Typical “Rigid” pipe supports as referenced in the Drawings refer to supports designed to fix one point in the pipe and not pivot or rotate due to expansion and contraction.

2.4 SPARE PARTS

A. The CONTRACTOR shall provide spare parts, properly boxed, and tagged in accordance with Section 11000 – Equipment General Provisions.

B. Provide the following spare parts for each aeration train:

a. Two (2) Diffuser assemblies completely factory assembled.

b. Ten (10) Membrane sleeves.

c. Twenty (20) stainless steel membrane clamps.

2.5 MANUFACTURERS

A. MANUFACTURER’s Experience:

1. The aeration diffuser system including drop pipes, header pipes, distribution pipes and diffusers shall be furnished by a single MANUFACTURER who is fully experienced, reputable, and qualified in the manufacture of the equipment to be supplied.

2. The supplier shall have experience in the design, manufacture, supply and commissioning of fine pore, flexible membrane aeration equipment identical to the type specified for this project.

3. The equipment submitted shall be of proven design and shall be referenced by at least three installations of similar size, having been in successful operation for a period of not less than four (4) years prior to bid date.

4. If the Contractor elects to submit a substitute aeration system that does not comply with the above experience requirements, a bond guaranteeing the replacement of the aeration system shall be provided with the submittal package.

   a. The bond term shall be for a period of five (5) years. This term shall include the specified warranty period plus three (3) additional years.

   b. If the operation of the aeration system as determined by the Owner is unsatisfactory, the Contractor shall repair, modify or replace the entire aeration system in a manner acceptable to the Owner.

   c. Normal wear or malfunctions due to neglect or abuse shall not be considered justifiable reasons for unsatisfactory operations.

   d. The presence of chemical compounds that are aggressive to the membrane material are not considered as normal wear or service.

   e. If the Contractor fails to correct deficiencies identified by the Owner within six (6) months of the date first notified in writing, the Owner shall at its own discretion make all necessary repairs or replacement and deduct all associated costs from the Contractor's bond.

B. MANUFACTURER:

1. Environmental Dynamics International (EDI).

2 Information on alternate manufacturers shall be submitted to the Design Engineer no less than 2 weeks prior to the bid date. Only pre-approved, named manufacturers are acceptable. Approvals will be based on meeting detailed specifications in the contract documents.

2.6 DELIVERY AND STORAGE

A. A complete set of MANUFACTURER's instructions covering storage, installation, operation, lubrication, and maintenance shall be furnished to the OWNER no later than the date the equipment is shipped. Care during storage and procedures for installation, lubrication, and startup of the equipment and motors shall be in strict conformance with the MANUFACTURER's instructions.

B. All un-plasticized polyvinyl chloride (UPVC) components of the fine bubble aeration system stored on site shall be adequately protected from prolonged exposure to direct sunlight and extreme temperature change. The materials shall be stored in a manner which prevents physical damage to the system components. Installation of UPVC aeration

system components shall be scheduled during periods of the day and year when temperatures are not at extremes, hot or cold, to prevent damage due to thermal expansion. Upon the completion of installation of all UPVC aeration system components in the aeration basins, the basins shall be filled with clean water to a depth at least four feet above the highest UPVC component to protect the system from sunlight and extreme temperature changes. The CONTRACTOR will be responsible for controlling the quality of the water in the aeration basins and shall take appropriate action to control biological growth, such as algae, which may damage the fine bubble aeration system.

2.7 INSTALLATION

A. Furnish, inspect, store, and install in accordance with the MANUFACTURER's printed instructions and approved submittals.

B. Diffuser assemblies on a common grid shall be installed within an elevation tolerance of ±1/2 inches.

C. Contractor shall provide all valves, air header piping, wall sleeves with seals, wall pipes, and concrete pedestals as necessary to complete the system as shown on the plans.

D. Air piping including blower manifold, header, and in-basin piping must be clean prior to delivering air up the diffusers.

E. Contractor shall be responsible for cleanliness of piping and may be required to manually clean pipe, or air or water flush piping as required.

2.8 TESTING

A. General

1. Upon completion of the installation, each piece of equipment and each system shall be tested for satisfactory operation without excessive noise, vibration, etc. All equipment must be adjusted and checked for misalignment, clearances, supports, and adherence to safety standards. Other performance tests required are included in the following Paragraphs of this Section

B. Factory Testing

1. Uniformity Test: Test diffusers in a plan to show that 95 percent of the diffusers within a given lot meet the uniformity requirement. Uniformity is defined as substantially even distribution of air bubbles across the diffuser surface when the diffuser is submerged and operating at 0.5 scfm. One diffuser from each 25 shall be tested.

2. Dynamic Wet Pressure Test: All diffusers tested for uniformity shall also be tested for dynamic wet pressure in accordance with an approved testing procedure. The dynamic wet pressure is the pressure drop across a wetted diffuser element at a given air flow rate.

3. A test plan designed to meet the above requirements shall be submitted by the CONTRACTOR for the ENGINEER's review. Five percent of the diffusers shall be tested. Ninety-five percent of diffusers tested shall fall within 15 percent of the indicated permeability. If this condition is not met, however, all elements to be

shipped to the job site shall be tested. In any case, all diffuser elements not satisfying the test requirements shall be rejected. The remaining elements, which meet the requirements, shall be accepted in regard to the given test parameter.

4. Oxygen Transfer Test: Concurrent with shop drawing submittal, the CONTRACTOR shall furnish data from an independent testing laboratory certifying the performance of the diffusers in clean water in compliance with the latest ASCE standard for Measurement of Oxygen Transfer in Clean Water. Minimum oxygen transfer shall be as indicated in the Performance Requirements. Spacing, permeability, average air flow rate and all other properties for the test diffusers shall be essentially identical to those of the full scale installation. A minimum of three test runs shall be made. The technique and results of the tests shall be certified by the independent laboratory and approved in advance by the ENGINEER. The CONTRACTOR shall give at least 10 days advance notice to the ENGINEER to enable him to witness the test, if he should so desire.

5. Witnesses: The OWNER and the ENGINEER (at the option of either) reserve the right to witness factory testing.

C. Functional Testing

1. Field Tests: At least 10 days prior to the performance of field tests, the CONTRACTOR shall notify the ENGINEER in writing when these tests are to be performed. The CONTRACTOR and ENGINEER shall agree upon the actual time the tests are to be performed. The CONTRACTOR shall furnish all labor, equipment, and materials required to perform the tests. All defects shall be corrected by the CONTRACTOR and all required retesting shall be performed by the CONTRACTOR at no additional cost to the OWNER.

2. Level Tests:

   a. Each aeration basin shall be flooded with potable water to the bottom of the diffuser assemblies. Adjust the pipe supports and diffuser assemblies such that all diffuser units are installed within ±1/2 inches of the design diffuser elevation.

3. Uniformity and Leakage Tests:

   a. Each aeration basin shall be flooded with potable water to a level of 2 feet above the top of the diffusers.

   b. Process air shall be supplied evenly to all headers in each basin and inspect the system for air leaks at all piping or diffuser connections.

   c. Check all membrane for cuts or tears that may have occurred during the installation.

   d. Adjust any piping or diffusers that show leaks or disproportionate amount of airflow.

   e. Operate the blowers at the design air rate and observe air release and air distribution patterns.

f. The surface of the water above the diffusers shall then be visually inspected to ensure that air flow is uniformly distributed across the basin.

g. All water, air, power and labor associated with testing and adjustment of diffuser assemblies are to be supplied by Contractor.

END OF SECTION

SECTION 11455 – AERATION DIFFUSERS, COARSE BUBBLE

PART 1 GENERAL

1.1 THE REQUIREMENT

A. The WORK of this Section includes providing one (1) coarse bubble diffuser system for the scum box located at RAS Pump Station North and (3) coarse bubble diffuser systems, one for each of three WAS Storage Tanks.

B. All equipment shall be provided complete with all accessories connections, supports, and anchors necessary for a workable system. The coarse bubble system shall be defined as risers, valves, lifting lugs, fittings, connections, couplings, distribution headers, diffusers, supports and anchors, extending from the air header but excluding the air header itself, through the individual diffusers.

C. One responsible MANUFACTURER shall manufacture the principal elements and components including, as a minimum, the diffusers.

1.2 REFERENCE SPECIFICATIONS, CODES, AND STANDARDS

A. ASTM A240-81 Heat-Resisting Chromium and Chromium Nickel Stainless Steel Plate, Sheet, and Strip for Fusion-Welded Unfired Pressure Vessels

B. ASTM A276-81 Stainless and Heat-Resisting Steel Bars and Shapes

C. ASTM A312-81 Seamless and Welded Austenitic Stainless Steel Pipe

D. ASTM A403-81 Wrought Austenitic Stainless Steel Pipe Fittings

1.3 CONTRACTOR SUBMITTALS

A. General: CONTRACTOR shall submit administrative, shop drawings, samples, quality control, and contract closeout submittals of all equipment furnished this Section and in referenced Sections.

B. Shop Drawings and Samples: Shop drawings and samples shall be submitted in accordance with the requirements of Section 01340 Shop Drawings, Product Data and Samples. CONTRACTOR shall also submit the following:

1. Descriptive literature and dimensional drawings for all equipment including, but not limited to, the air feed main, air distribution main, and diffuser assemblies indicating materials of construction, number, spacing, and location of diffusers, layout and size of air feed, and distribution mains.

2. Description and dimensional drawing showing the proposed method of supporting the air feed and distribution piping as required to prevent uncontrolled movement due to flotation and dynamic forces.

3. Descriptive literature and dimensional drawings showing the proposed method of compensation for thermal expansion and contraction in the aeration system.

4. Proposed method of draining water from the aeration system piping when the aeration basins are full of liquid.

5. The recommended minimum design and maximum air flows per diffuser.

6. Head loss calculations for the air diffusers, flow control orifices, and system piping for the design airflow conditions specified.

7. A testing plan designed to ensure consistently good quality and uniformity of the diffuser assemblies, including a sampling plan.

8. A complete shop welding procedure for stainless steel pipe.

9. A curve showing the oxygen transfer efficiency of the proposed system at different air flow rates in the design range (efficiency versus air flow rate at proposed depth).

10. Information on at least one successfully performing installation of comparable size and complexity constructed in the recent past, including contact name, telephone number, and address.

C. O & M Manuals: The CONTRACTOR shall provide operators and maintenance data for all equipment furnished for the project in accordance with Section 01730, Operation and Maintenance Data.

D. Tools: Special tools necessary for maintenance and repair of the equipment shall be furnished as a part of the WORK hereunder; such tools shall be suitably stored in metal tool boxes, and identified with the equipment number by means of stainless steel or solid plastic name tags attached to the box.

1.4 QUALITY ASSURANCE

A. CONTRACTOR shall submit the following:

1. MANUFACTURER's Certificate of Proper Installation

2. Functional Test Certification

3. Factory performance test reports

4. Special shipping, storage and protection, and handling instructions

5. MANUFACTURER's printed installation instructions

6. List of suggested spare parts to maintain the equipment in service for a period of 5 years. Include a list of special tools required for checking, testing, parts replacement, and maintenance.

7. List of special tools, materials, and supplies furnished with equipment for use prior to and during startup.

B. Warranty

1. A written suppliers warranty shall be provided for the equipment specified in this section as required in Section 11.2, General Conditions.

1.5 MANUFACTURERS SERVICE REPRESENTATIVE

A. Manufacturer's Representative. In accordance with the requirements of Section 01660 Testing and Training, a Manufacturer's Representative shall be present at the site or classroom designated by the OWNER to provide the services and minimum person-days listed below, travel time excluded.

1. 1 person-days for installation assistance and inspection,

2. 1 person-days for functional and performance testing

3. 0.5 person-days for pre-startup training of OWNER's personnel.

PART 2 PRODUCTS

2.1 GENERAL

A. Diffuser systems shall be provided and shall meet or exceed operating criteria as follows:

Application	**Scum Box**	**WAS Storage Tanks**
Air Flow per diffuser (scfm)	8.4	19
Diffuser spacing (ft O.C.)	1.6	2.1
Maximum diffuser submergence (ft)	14.4	19
Diffuser headloss (inches water column)		
At maximum flow	6	6
At minimum flow	1	1

B. Environmental Conditions: Air diffusion equipment shall be designed for submergence in municipal wastewater containing sand, gravel, bits of metal, and dilute concentration of petroleum products, industrial solvents, 20 to 30 parts per million of ferric chloride, and detergents. Water temperature is expected to range from 55 to 85 degrees F.

2.2 ELEMENTS OF DIFFUSER ASSEMBLIES

A. General: Each aeration air diffusion assembly shall consist of air diffusers, air headers, and a removable hanger feed pipe. Assemblies shall be supported at intervals and spaced as indicated. Each aeration air diffusion assembly shall be constructed to allow easy removal as a complete unit without drawing down the level of the liquid in the channels. Assemblies shall be designed for not more than a 15-inch water column air

pressure loss between the air main and the last air diffuser inlet when operating at an aeration air flow rate of 8 scfm per diffuser.

B. Distribution Headers: Distribution headers shall be at least 3 inches in diameter, comprised of two sections of Type 316L stainless steel 12 gauge pipe welded to flanges which attach to a cross fitting as indicated. Each section of pipe shall be approximately 10 feet long, unless otherwise indicated on the drawings. The outer ends of each distribution header shall terminate in removable pipe caps. Each distribution header section shall be equipped with 3/4-inch, double ended, tee shaped, forged Type 316L stainless steel bosses, welded on. Such bosses shall be accurately drilled and tapped for 3/4-inch pipe threads to receive diffuser tubes or pipe plugs, as indicated. All bosses on each header section shall be on a perfectly straight line and shall be drilled and tapped in a drilling fixture to provide level installation of diffusers. Bosses shall be attached to the bottom centerline of the header sections.

C. Air Riser Pipes: Each air riser pipe shall be at least 3 inches in diameter, comprised of one section of Type 316L stainless steel, 12 gauge pipe, an elbow or tee, and flanges and mechanical pipe couplings as indicated. The upper elbow or tee shall include a lifting hook. Connections between the riser pipe and header shall be flanged. The hanger feed pipe shall serve as a support for the riser pipe.

D. Diffusers: Single or twin-type diffuser heads with threaded or clamped saddle connections to diffuser header. The heads shall be of molded, synthetic resin, stainless steel, or other material suitable for this service.

E. Lifting Lugs: Individual aeration air assemblies and each field disassemble-able part over 100 pounds in weight shall be provided with lifting lugs for easy handling.

F. Spare parts: Five diffusers shall be furnished, properly boxed, and tagged in accordance with Section 11000, Equipment General Provisions.

2.3 MANUFACTURERS

A. MANUFACTURER's Experience: The materials and equipment covered by this specification are intended to be standard materials and equipment of demonstrated successful performance and supplied by a manufacturer who has been actively engaged in the supply of similarly sized coarse bubble diffuser systems for a minimum of 5 years. Equipment shall be designed and constructed in accordance with the highest standards of the industry and shall be installed in accordance with the MANUFACTURER's recommendations and the Contract Documents.

B. Manufacturers or Approved Equal:

1. Sanitaire

2. EDI

PART 3 EXECUTION

3.1 DELIVERY AND STORAGE

A. A complete set of MANUFACTURER's instructions covering storage, installation, operation, lubrication, and maintenance shall be furnished to the OWNER no later than the date the equipment is shipped. Care during storage and procedures for installation,

lubrication, and startup of the equipment and motors shall be in strict conformance with the MANUFACTURER's instructions.

3.2 INSTALLATION

A. Install in accordance with the MANUFACTURER's printed instructions.

B. Particular care shall be taken to ensure that all diffusers are installed in a single horizontal plane within a tolerance of plus or minus 1/8-inch. A MANUFACTURER's certificate of installation shall be provided.

C. Cleaning and Testing: The CONTRACTOR shall carefully clean all piping, headers, and accessories through which air is delivered so that all dust, dirt, oil, grease, or other foreign material will be effectively removed. This cleaning shall be done with clean water and an acceptable solvent at a velocity of 2 to 3 feet per second.

D. After the piping has been completely cleaned, it shall be thoroughly flushed with water. The installation of diffuser units shall not begin until the air distribution assembly has been cleaned and inspected.

3.3 TESTING

A. After the piping, headers, and diffuser units have been installed, water shall be introduced into the structure until the diffuser units have been covered about 2 inches. Compressed air shall then be released through the diffuser units and any leaks and improperly aligned diffusers shall be repaired. This test shall be repeated until the entire system is airtight and properly aligned.

B. Final testing shall include operation of all of the assemblies with all of the headworks channel and aeration basin effluent channel structures full to the design operating depth with water. The CONTRACTOR shall balance the system and perform air flow and pressure testing with the system on line. Air meters and gauges, if installed in the piping system, may be used for air flow testing, otherwise they shall be installed for test purposes only and removed at the end of testing, at no additional cost to the OWNER. The CONTRACTOR shall submit a complete report to the ENGINEER upon completion of the air assembly testing.

END OF SECTION

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SECTION 11500 – BLOWERS, COMPRESSORS, AND VACUUM PUMPS, GENERAL

PART 1 GENERAL

1.1 THE REQUIREMENT

A. The CONTRACTOR shall furnish and install all tools, supplies, materials, equipment and labor necessary for the installation, testing, and placing into operation of all blowers, compressors, and vacuum pumps and appurtenances, complete and operable, in accordance with the requirements of the Contract Documents.

B. The provisions of this Section shall apply to all blowers, compressors, and vacuum pumps and equipment specified, except where otherwise specified in the Contract Documents.

C. The CONTRACTOR shall assign to a single MANUFACTURER full responsibility for the furnishing and functional operation of each type of blower, compressor, or vacuum pump unit(s) including drives, drive motors, speed control equipment (where variable speed drives are required), and accessories. The MANUFACTURER shall also provide any required control panels with required circuit breakers, motor starters, required selector switches, pushbuttons, and lights in conformance with Section 11000. The designated single MANUFACTURER, however, need not manufacture more than one part of the unit(s) (blower, or motor and drive) unless specified otherwise, but shall coordinate the design, assembly, testing, and erection of the unit(s) as specified herein.

1.2 REFERENCE SPECIFICATIONS, CODES, AND STANDARDS

ANSI B16.1	Cast Iron Pipe Flanges and Flanged Fittings, Class 25, 125, 250, and 800
ANSI B16.5	Pipe Flanges and Flanged Fittings, Steel Nickel Alloy and Other Special Alloys
ANSI/ASME PTC 9	Performance Test Code - Displacement Compressors, Vacuum Pumps and Blowers
ANSI/ASME PTC 10	Performance Test Code - Compressors and Exhausters
ANSI/ASME B31.1	Power Piping
ANSI/IEEE 112	Test Procedure for Polyphase Induction Motors and Generators
ASTM A 48	Specification for Gray Iron Castings.

1.3 CONTRACTOR SUBMITTALS

A. General: CONTRACTOR shall submit administrative, shop drawings, samples, quality control, and contract closeout submittals of all equipment furnished this Section and in referenced Sections in accordance with the requirements of Section 01340 Shop Drawings, Product Data and Samples.

B. General Submittals and Shop Drawings: In addition to the requirements of Section 01340, CONTRACTOR shall submit the following:

1. Equipment name, identification number, and specification number.

2. Performance curve and data.

3. The CONTRACTOR shall require the MANUFACTURER to indicate points on the H/Q curves, and the limits recommended for stable operation between which the blowers may be operated without surge and vibration. The stable operating range shall be as wide as possible based on actual tests, performed at the factory in accordance with the ANSI/ASME PTC 9 and 10 test codes.

4. Equipment detailed description and specification.

5. Electrical data including control and wiring diagrams.

6. Assembly and installation drawings including shaft size, seal, coupling, anchor bolt plan, part nomenclature, material list, outline dimensions and shipping weights.

7. Equipment drive and motor submittals in accordance with Section 16220 – Low Voltage Motors.

8. Special shipping, storage and protection, and handling instructions

9. MANUFACTURER's printed installation instructions

10. List of suggested spare parts to maintain the equipment in service for a period of 5 years. Include a list of special tools required for checking, testing, parts replacement, and maintenance.

11. List of special tools, materials, and supplies furnished with equipment for use prior to and during startup.

C. O & M Manuals: The CONTRACTOR shall provide operations and maintenance data for all equipment furnished for the project in accordance with Section 01730 - Operation and Maintenance Data.

D. Tools: Special tools necessary for maintenance and repair of the equipment shall be furnished as a part of the WORK hereunder; such tools shall be suitably stored in metal tool boxes, and identified with the equipment number by means of stainless steel or solid plastic name tags attached to the box.

1.4 QUALITY ASSURANCE:

A. CONTRACTOR shall submit the following:

1. MANUFACTURER's Certificate of Proper Installation

2. Functional Test Certification

3. Factory performance certified test reports

B. Warranty

1. A written suppliers warranty shall be provided for the equipment specified in this section as required in Section 11.2, General Conditions.

1.5 MANUFACTURERS SERVICE REPRESENTATIVE

A. MANUFACTURER's Representative. In accordance with the requirements of Section 01660, a MANUFACTURER's Representative shall be present at the site or classroom designated by the OWNER to provide the services and minimum person-days listed below, travel time excluded for each blower and compressor unit 10 hp and larger.

1. 1 person-days (minimum) for installation assistance and inspection,

2. 1 person-days (minimum) for functional and performance testing

3. 1 person-days (minimum) for pre-startup training of OWNER's personnel.

PART 2 PRODUCTS

2.1 GENERAL

A. Wherever it is specified that a single designated MANUFACTURER shall be responsible for the compatible and successful operation of the various components of any equipment, it shall be understood to mean that the CONTRACTOR shall furnish and install only such equipment as the MANUFACTURER will certify is compatible with its equipment and with the further understanding that this in no way constitutes a waiver of any specified requirements.

B. All manufactured items provided under this Section shall be new, current model, and the products of reputable companies specializing in the manufacture of such products, with previous experience in such manufacture and shall, upon request of the ENGINEER, furnish the names of not less than 5 successful installations of its equipment of comparable nature to that offered under this Contract.

C. Where 2 or more units of the same type and/or size of equipment are required, such units shall all be produced by the same MANUFACTURER.

D. Appurtenances

1. Nameplates: Each blower, compressor, vacuum pump, and motor shall be equipped with a stainless steel nameplate indicating rated head and capacity, impeller size, speed, and MANUFACTURER's name, serial, and model number. Nameplates for electric motors shall be in accordance with Section 16220 – Low Voltage Motors.

2. Solenoid Valves: Solenoid valves shall be furnished and installed on the water or oil lubrication and cooling lines. Solenoid valve electrical rating shall be compatible with the motor control voltage and shall be furnished complete with all necessary conduit and wiring installation from control panel to solenoid.

3. Gauges: All blowers, compressors, and vacuum pumps shall be equipped with pressure or vacuum gauges, respectively, installed in the discharge lines.

Pressure gauges shall be located in a representative location, where not subject to shock or vibrations, in order to achieve true and accurate readings. Pressure gauges shall be furnished in conformance with Section 13400 – Common Work Results Process Instrumentation and Controls. Where subject to shock or vibrations, the pressure gauges shall be wall-mounted or attached to galvanized channel floor stands and connected by means of flexible connectors.

4. Variable Speed Drives, where applicable: Variable speed drives, drive motors, speed control equipment, and accessories shall be furnished in accordance with Section 16260 - Low Voltage Adjustable Speed Drive Motor Controllers.

5. Electric Motors: Electric motors shall comply with the requirements of Section 16220 – Low Voltage Motors.

6. Flanges: Suction and discharge flanges shall conform to ANSI B16.1 or B16.5 dimensions.

7. Lubrication: Blowers, compressors, vacuum pumps, and motors shall be oil or grease lubricated as per individual specifications.

8. Drains: All cooling water drains, and drains from variable speed drive equipment shall be piped to the nearest floor sink, or drain, with galvanized steel pipe or copper tube, properly supported with brackets.

E. Materials of Construction:

1. All materials employed in the blower, compressor, and vacuum pump equipment shall be suitable for the intended application; material not specifically called for shall be high-grade, standard commercial quality, free from any defects and imperfections that might affect the serviceability of the product for the purpose for which it is intended, and shall conform to the following requirements:

   a. Cast iron casings shall be of close-grained gray cast iron, conforming to ASTM A 48, or equal.
   b. Stainless steel shafts shall be of Type 400, Series. Miscellaneous stainless steel parts shall be of Type 316.
   c. All anchor bolts, nuts and washers shall be hot-dip galvanized, unless otherwise specified in individual equipment specifications.

F. Spare Parts:

1. The CONTRACTOR shall obtain from the MANUFACTURER a list of suggested spare parts of all items of each blower, compressor, and vacuum pump, motor, and drive, subject to wear, such as seals, packing, gaskets, nuts, bolts, washers, wear rings, etc., as well as a set of spare bearings, and one year's supply of filter elements. Furnish all these parts suitably packaged and labeled in a box as described below for tools.

G. Tools:

1. Special tools necessary for maintenance and repair of the equipment and one pressure grease gun for each type of grease required for blowers, compressors, and motors shall be furnished as a part of the WORK hereunder; such tools shall

be suitably stored in metal tool boxes, and identified with the equipment number by means of stainless steel or solid plastic name tags attached to the box.

PART 3 EXECUTION

3.1 DELIVERY AND STORAGE

A. Complete set of MANUFACTURER's instructions covering storage, installation, operation, lubrication, and maintenance shall be furnished to the OWNER no later than the date the equipment is shipped. Care during storage and procedures for installation, lubrication, and startup of the equipment and motors shall be in strict conformance with the MANUFACTURER's instructions.

3.2 INSTALLATION

A. CONTRACTOR shall install equipment in accordance with the MANUFACTURER's printed instructions.

B. Alignment: Equipment shall be field tested to verify proper alignment and operation as specified, and freedom from binding, scraping, excessive noise, overheating, vibration, shaft runout, or other defects. Drive shafts shall be measured just prior to assembly to ensure correct alignment without forcing. Equipment shall be secure in position and neat in appearance.

C. Piping and Mounting: All piping shall be provided with sufficient expansion joints, guides, and anchors and be supported so as to preclude the possibility of exerting undue forces and moments on the equipment flanges. Suitable flexible connectors shall be furnished to isolate the equipment from the piping system. Each unit shall be mounted on a flat and level concrete pad capable of supporting the dead weight of the unit, by means of restrained vibration isolators or resilient pads of suitable design, as specified.

D. Lubricants: The installation work shall include furnishing the necessary oil and grease for initial operation and for one year's operation.

3.3 TESTING

A. General:

1. The CONTRACTOR shall be responsible for the coordination of the following tests of each blower, compressor, and vacuum pump, drive, and motor.

2. Tests shall be performed in accordance with the ANSI/ASME PTC 9 and 10 Performance Test Codes. Tests shall be performed on the actual assembled unit from surge condition to 25 percent above the required design capacity. Prototype model tests will not be acceptable. Equipment shall be factory witness-tested, as defined herein.

B. Factory Testing:

1. All blowers, compressors and motors of sizes 10 to 125 hp (inclusive) shall be factory-tested in accordance with the above specifications. Certified test data shall be submitted to the ENGINEER.

2. All motors of size 10 hp and larger, shall be assembled, tested, and certified at the factory and the working clearances checked to insure that all parts are properly fitted. The tests shall be in accordance with ANSI/IEEE 112 standards, including heat run and efficiency tests. All computations shall be recorded and certified and dated copies of the test results shall be furnished to the ENGINEER.

3. All blowers and compressors and motors 150 hp and larger shall be factory-tested as complete assembled units, as specified above, and witnessed by the ENGINEER. The CONTRACTOR shall give the ENGINEER a minimum of 2 weeks notification prior to the test. Test results shall be submitted to the ENGINEER and no equipment shall be shipped until the test data have been approved by the ENGINEER.

4. Acceptance: In the event of failure of any blower or compressor to meet any of the above requirements or efficiencies, the CONTRACTOR shall make all necessary modifications, repairs, or replacements to conform to the requirements of the Contract Documents and the equipment shall be re-tested at no additional compensation, until found satisfactory by the OWNER/ENGINEER.

C. Functional and Performance Testing

1. All units shall be field tested after installation, in accordance with the Contract Documents, to demonstrate satisfactory operation, without causing excessive noise, vibration, and overheating of the bearings. The field testing shall be performed by the CONTRACTOR in the presence of a factory-trained, experienced field representative of the MANUFACTURER, who shall supervise the following tasks and shall certify in writing that the equipment and controls have been properly installed, aligned, lubricated, adjusted, and readied for operation:

   a. Start-up, check, and operate the equipment over the entire speed range. The vibration shall be within acceptable limits.
   b. Equipment performance shall be documented by obtaining concurrent readings, showing motor voltage, amperage, and discharge head. Each power lead to the motor shall be checked for proper current balance.
   c. Bearing temperatures shall be determined by a contact-type thermometer. A running time of at least 20 minutes shall be maintained for this test.
   d. Electrical and instrumentation testing shall conform to applicable sections of these Specifications.

2. The field testing shall be witnessed by the OWNER or its representative. In the event any of the equipment fails to meet the above test requirements, it shall be modified and retested in accordance with the requirements of these Specifications. The CONTRACTOR shall then certify in writing that the equipment has been satisfactorily tested, and that all final adjustments thereto have been made. Certification shall include date of final acceptance test, as well as a listing of all persons present during tests, and resulting test data. The costs of all work performed in this Subsection by factory-trained representatives shall be borne by the CONTRACTOR. The OWNER will pay for power costs. When available, the OWNER'S operating personnel will provide assistance in the field testing.

END OF SECTION

SECTION 11502 – GEARED SINGLE STAGE CENTRIFUGAL BLOWER PACKAGES

PART 1 GENERAL

1.1 THE REQUIREMENT

A. The BLOWER SYSTEM SUPPLIER and CONTRACTOR shall furnish and install a single stage centrifugal blower package system for aeration service. The blower package shall be complete with four (4) single stage blowers with electric motors, associated instrumentation and controls, associated appurtenances, piping, fittings, valves, connectors, and local control panels to obtain a workable installation suitable for continuous operation 24 hours per day as shown and specified herein in accordance with the requirements of the Contract Documents. The blower package system includes but is not limited to:

1. Four (4) geared single state centrifugal air blower unit systems. Unit systems include the blower, motor, inlet silencer/filter, flexible compensator, discharge diffuser, blow-off valve/silencer, check valve, actuated isolation valve, silencer blocks/mounts, frame assembly, outside air inlet louver adapter, instrumentation, and local control panel (LCP).

B. The BLOWER SYSTEM SUPPLIER shall also design and provide the Aeration Control System and associated appurtenances, instrumentation, and controls as specified in Section 13550, Aeration Control System and per Section 11000, Equipment General Provisions.

C. The system shown on the Drawings is based on the supply of the first-named Supplier, Manufacturer, or Vendor. The Drawings show a general depiction of the equipment and indicate a level of accessibility and clearances that shall be required for installation and maintenance of the system components. The specific location of system connections and equipment may vary depending on the System Supplier. Additionally, the quantity and methods used for meeting the Contract requirements for safety may differ between what is provided by the System Suppliers and what is shown on the Contract Drawings. The supplied system shall fit within the footprints shown on the Drawings while maintaining the level of accessibility and clearances shown on the Drawings. If the Contractor selects a System Suppler other than the first-named System Supplier, Contractor shall be responsible for the cost of all modifications required to provide the accessibility and clearance requirements, and modifications required of equipment that are tailored to the specific system design at no additional cost to the Owner. Such changes to the layout shall not impair the equipment accessibility or limit maintenance access as generally indicated on the Drawings, nor shall it relieve the System Supplier's responsibility for meeting the requirements of the Contract Documents. Any re-design of structures, foundations, support utilities, or any other related infrastructure needed to accommodate other than the first-named Supplier shall be borne by the Contractor, without additional cost to the Owner; any such re-design of related infrastructure shall be by the Owner's design engineer. Any costs associated with the Owner's design engineer evaluation of Contractor proposed alternate System Suppliers shall be borne by the Contractor.

D. All equipment specified in this section shall be designed and furnished by the BLOWER SYSTEM SUPPLIER, who shall be responsible for the suitability and compatibility of all included equipment as required for a complete and automated aeration system.

E. All equipment specified in this section shall be installed by the CONTRACTOR.

F. All equipment, valves, actuators, instrumentation and controls systems of the same type shall be by a single manufacturer. Selected equipment, valves, actuators, instrumentation and controls systems manufacturers on the project shall be identified in the construction bid form “Schedule of Major Equipment and Material Suppliers, Products Identified by Name and Substitution”.

G. The BLOWER SYSTEM SUPPLIER and CONTRACTOR shall provide geared single state centrifugal air blowers in accordance with Section 11500 - Blowers, Compressors, Vacuum Pumps, General.

1.2 REFERENCE SPECIFICATIONS, CODES, AND STANDARDS

A. Reference Specifications

1. Section 01340 - Shop Drawings, Product Data and Samples.
2. Section 01660 - Testing and Training
3. Section 01730 - Operation and Maintenance Data
4. Section 09900 - Paintings and Coating
5. Section 11500 - Blowers, Compressors, Vacuum Pumps General
6. Section 13400 – Common Work Results Process Instrumentation and Controls
7. Section 13431 – Instrumentation and Controls – Analytical Devices
8. Section 13432 – Instrumentation and Controls – Flow Measurement
9. Section 13433 – Instrumentation and Controls – Level Measurement
10. Section 13434 – Instrumentation and Controls – Pressure Measurement
11. Section 13435 – Instrumentation and Controls – Temperature Measurement
12. Section 13446 – Electrical Operators for Valves and Gates
13. Section 13482 – Process Control Descriptions
14. Section 13550 – Aeration Control System.
15. Section 11000 – Equipment General Provisions.
16. Section 15200 – Valves General
17. Section 15201 – Valve and Gate Actuators
18. Section 15214 – Pressure Control Valves
19. Section 15203 – Check Valves
20. Section 15230 – Miscellaneous Valves

21. Section 15214 – Pressure Control Valves

22. Division 16 – Electrical

23. Section 16220 – Low Voltage Motors

24. Section 16265 – Reduced Voltage Solid State Motor Controllers

1.3 CONTRACTOR SUBMITTALS

A. General: BLOWER SYSTEM SUPPLIER and CONTRACTOR shall submit administrative, shop drawings, samples, quality control, and contract closeout submittals of all equipment furnished this Section and in referenced Sections in accordance with the requirements of Section 01340 Shop Drawings, Product Data and Samples.

B. General: The BLOWER SYSTEM SUPPLIER and CONTRACTOR shall provide submittals in accordance with Section 11500 - Blowers, Compressors, Vacuum Pumps General and Section 11000 Equipment General Provisions. Additional submittal information shall be provided as specified herein and a specified in referenced Sections.

C. Shop Drawings and Samples: In addition to the requirements of Section 01340- Shop Drawings, Product Data and Samples, BLOWER SYSTEM SUPPLIER and CONTRACTOR shall submit the following:

1. General description of blower with all performance data, blower curves, and model.

2. A speed-torque curve for the blower computed for specified minimum inlet temperature. Certify that the motor starting torque is compatible with blower requirements.

3. Mechanical drawings with general arrangement showing blower base dimensions, floor mounting, skid piping, overall weights with and without oil, weights of largest components requiring removal for maintenance, and clearances required around unit for maintenance access. Describe method of maintenance access for containerized blower and accessories.

4. Provide the following submittals as described in Sections 11000 – Equipment General Provisions:

   a. Product submittals
   b. Schematic diagrams
   c. Loop diagrams
   d. Field wiring interconnection diagram

5. Motor data as required under Section 16220

6. A detailed blower factory test plan with complete piping and instrumentation configuration diagram per ASME PTC-10 showing inlet and discharge air test pipe size. The location, type, and quantity of all major instruments necessary for performance data, including those on air, water, and lube oil with corresponding

distances from reference points, shall be identified. As a minimum, the detailed test plan shall include:

a. Insert the actual ASME PTC-10 test report in the O&M manual.

b. Functional testing of entire blower package, including blower instrumentation, ancillary components, and local control panels.

7. Unloading, handling, storage, and maintenance requirements

8. Recommended lubricants

9. Surface preparation and shop paint specifications

10. Instrument settings including calibrated ranges and expected operating set points

11. Troubleshooting guide

12. List of components and catalog cuts fully describing all items and as specified in 11000:

    a. Mechanical and structural components of container and blower
    b. Instruments
    c. PLC
    d. Control panels and their components
    e. Electrical components

13. Submit the following additional submittals:

    a. Provide detailed information on structural, mechanical, electrical, or other changes or modifications necessary to adapt non-specified materials to the arrangement or details shown in the Contract Documents.

    b. Process and instrumentation diagrams.

    c. Drawings of all control panels to include:

        1) Electrical ladder diagram
        2) Interconnects to all components outside the panel
        3) Door layout
        4) Interior layout
        5) Sample Operator Interface screens for the local and master control panel

    d. Provide a main drive motor start analysis showing compliance with motor acceleration requirements, line current limits, and generally that the starter (provided under Section 16265) and motor combination will accelerate the load to full speed within the specified parameters.

    e. Operating description for the local (and master) control panels. As a minimum, provide a more detailed description than given in this specification, covering all logic and sequences of operation.

f. Provide a detailed description of the data acquisition, remote monitoring, and predicted preventative maintenance software. Typical Operator Interface screens shall be provided with detailed descriptions, the various tattletale monitors, preventative maintenance items, and data logging features.

g. Provide a detailed description that demonstrates the simultaneous and continuous efficiency optimization of the inlet guide vanes and variable diffuser vanes to obtain the lowest power consumption based on the three (3) variables of discharge temperature, differential pressure, and machine capacity.

D. Provide PLC and MCP interconnection schematic diagrams. The supplier of the systems specified in this Section shall provide information and prepare documentation as required in the development and submission of interconnection diagrams.

E. O & M Manuals: The BLOWER SYSTEM SUPPLIER and CONTRACTOR shall provide operations and maintenance data for all equipment furnished for the project in accordance with Section 01730, Operation and Maintenance Data.

F. Tools: Special tools necessary for maintenance and repair of the equipment shall be furnished as a part of the WORK hereunder; such tools shall be suitably stored in metal tool boxes, and identified with the equipment number by means of stainless steel or solid plastic name tags attached to the box.

G. Spare Parts: All spare parts shall be suitably packaged and clearly identified with indelible marking on the containers. Tools and spare parts (except for the air and oil filters) shall be supplied in a tool chest for long-term storage and marked with Manufacturer's name, along with a complete description of contents.

1.4 QUALITY ASSURANCE:

A. Quality assurance shall be in accordance with Section 11500, Blowers, Compressors, Vacuum Pumps, General and Section 11000 which includes but is not limited to the following:

1. MANUFACTURER's Certificate of Proper Installation

2. Functional Test Certification

3. Factory performance test reports

4. Special shipping, storage and protection, and handling instructions

5. MANUFACTURER's printed installation instructions

6. List of suggested spare parts to maintain the equipment in service for a period of 5 years. Include a list of special tools required for checking, testing, parts replacement, and maintenance.

7. List of special tools, materials, and supplies furnished with equipment for use prior to and during startup.

8. Control panel fabrication requirements

B. Warranty

1. A written Suppliers Warranty shall be provided for the equipment specified in this section as required in Section 11.2, General Conditions.

2. The equipment shall be guaranteed to meet or exceed the design criteria specified.

1.5 MANUFACTURERS SERVICE REPRESENTATIVE

A. MANUFACTURER'S Representative: In accordance with the requirements of Section 01660, Testing and Training and Section 11500 Blowers, Compressors, Vacuum Pumps General; a MANUFACTURER's Representative shall be present at the site or classroom designated by the OWNER to provide the services and minimum person-days listed below, travel time excluded.

1. One (1), eight-hour (8-hr.) days for each blower unit for installation assistance and final installation inspection

2. One (1), eight-hour (8-hr.) days for each blower unit for functional and performance testing

3. Three (3), eight-hour (8-hr.) days for the MCP (supplied under Section 13550 – Aeration Control System)

4. Three (3), eight-hour (8-hr.) days for each aeration train for functional testing, performance testing, adjustment and optimization of the aeration system valves and controls (supplied under Section 13550 – Aeration Control System)

5. Two (2), eight-hour (8-hr.) days for a factory representative, who has complete knowledge of proper operation and maintenance shall be provided to instruct representatives of the OWNER and ENGINEER on proper operation and maintenance, including pre-startup, start-up and shut-down procedures, proper lubrication practices, and troubleshooting of all equipment.

6. If there are difficulties in operation of the equipment due to the Manufacturer's fabrication or Contractor's installation, additional service shall be provided at no extra cost to the Owner.

PART 2 PRODUCTS

2.1 GENERAL

1. Three duty and one standby blowers will be used for supplying a variable volume of air to the aeration basin zones. The blowers specified herein, along with the master control panel (MCP), system software, air flow control valves, instrumentation, and accessories specified in Section 13550 – Aeration Control System, shall optimize system operation. All items specified in this section shall be supplied by the BLOWER SYSTEM SUPPLIER to provide a sole source responsibility for a properly functioning aeration system with the objective to minimize power consumption while providing the proper volume of air to each staged aeration basin zone.

2. All components shall be new. Both workmanship and materials shall be of the very best quality and conform to all applicable sections of these specifications. It shall be understood that components specified establish minimum requirements only, and do not relieve the BLOWER SYSTEM SUPPLIER or CONTRACTOR of responsibility for providing a properly functioning system.

3. The blowers shall be motor driven, single-stage centrifugal, vertical split type complete with integral gearbox and accessories as described herein. Each blower shall be provided with axial inlet, side discharge, with discharge adjustable radially in fifteen (15) degree increments.

4. Equipment to be provided by the BLOWER SYSTEM SUPPLIER includes:

   a. Single stage centrifugal blower
   b. motor
   c. inlet silencer/filter
   d. flexible compensator
   e. discharge diffuser
   f. blow-off valve/silencer
   g. check valve
   h. actuated isolation valve
   i. silencer blocks/mounts
   j. mounting frame assembly
   k. outside air inlet louver adapter
   l. instrumentation and controls associated with above equipment
   m. local control panel (LCP)
   n. Startup, testing, and training services
   o. Spare parts
   p. Other equipment and accessories as specified and as indicated on the plans

5. Blower reduced voltage solid state starter shall be provided per Section 16265.

6. Site Operating Conditions:

Location	Blower Building / Room
Service	Mixed liquor aeration
Geographic Location	Brentwood, CA 94513
Elevation above sea (ft)	79
Max Blower Room temperature (degree F)	90
Min Blower temperature (degree F)	23
Site Relative Humidity at Max Inlet Temperature (%)	46

2.2 PERFORMANCE REQUIREMENTS

A. Design Criteria: The blowers shall conform to the following conditions:

Maximum Flow rate per blower at 14.7 psia 68 deg F, and 36 percent RH (scfm)	4,650
Maximum flow rate per blower at site conditions (acfm)	5,107

Minimum Flow rate per blower at 14.7 psia 68 deg F, and 36 percent RH (scfm)	1,860
Minimum flow rate per blower at site conditions (acfm)	1,690
Design inlet temperature (deg F), min	23
Inlet temperature (deg F), max	113.7
Suction pressure – (psig)	14.7
Pressure at blower inlet (psig)	14.55
Design Discharge pressure (psig), max	7.8
Design inlet relative humidity, max (percent)	46
Inlet relative humidity, min (percent)	60
Motor size, max (hp)	200
Motor speed, max (rpm)	3,600
Flange rating (psi)	150
Sound pressure level at 5 feet (dBA max)	90
Design discharge temperature, (deg F), max	202

B. Performance Table: The blowers shall conform to the following conditions:

Characteristic	Point 1 (Design)	Point 2	Point 3	Point 4
Temperature (F)	113.7	80	60	23
Rel. Humidity (%)	46	46	50	60
Airflow Turndown (%)	100	80	60	40
Airflow (acfm)	5,258	3,844	2,756	1,696
Airflow (scfm)	4,650	3,720	2,790	1,860
Outlet Pressure (psig)	7.8	7.8	7.8	7.8
Shaft Power (hp)	192.7	142	110	79.2
Shaft Power (hp) + 2%	196.5	144.8	112.2	80.8
Evaluated Factor	0.10	0.40	0.40	0.10
Factored Power (hp)	19.6	57.9	44.9	8.1
Total Factored Power (hp)	130.5			

C. Extended Performance Table: The blowers shall conform to the following conditions:

Outlet Pressure (psig)	Airflow Turndown (%)	T = 113.7 F, rH = 46%		T = 80 F, rH = 46%		T = 60 F, rH = 46%		T = 23 F, rH = 60%	
		acfm	hp	acfm	hp	acfm	hp	acfm	hp
7.8	100	5,258	192.7	4,805	178.7	4,594	171.9	4,240	165.9
7.8	80	4,206	154.8	3,844	142	3,675	136	3,392	133.3
7.8	60	3,155	117.6	2,883	109.4	2,756	110	2,544	105.2
7.8	40	2,103	90.3	1,922	83	1,837	81.4	1,696	79.2

D. Blower power consumptions shall be guaranteed. Refer to the Factory Testing section of this specification.

E. Blowers shall not surge or exceed the nameplate motor rating over the entire range of operation. Blowers shall maintain a minimum of 0.5 psig rise-to-surge over the range of operation. Blowers with a rise-to-surge margin less than 0.5 psig shall not be accepted.

F. Blowers of a design requiring synchronization of air flow in order that two or more may operate in parallel shall not be acceptable; that is, the blowers shall operate in a cascade, not parallel, mode.

G. Noise Level: All provisions for reducing noise shall be incorporated and included in the Bid Price.

1. The maximum free field sound pressure level at any point at a distance of 5 feet or more from any blower/motor surface shall not exceed 90 dBA free field with the blower running at all speeds.

2. The specified maximum sound pressure level of 90 dBA free field includes the noise emitted from any possible source in the Blower Building, including but not limited to, the noise from motor; speed increaser gear; coupling; blower; inlet and discharge piping, fittings, and valves and silencers.

3. The sound pressure level shall be measured during the preliminary equipment tests of field testing after installation in the Blower Building and with one blower running.

4. If it is found that the actual sound pressure level 5 feet away from the blower exceeds the maximum specified sound pressure level, the MANUFACTURER shall make modifications and additions necessary to limit the noise to 90 dBA free field.

2.3 BLOWER AND INTEGRAL GEARBOX

A. Blower casing shall be made of Nodular cast iron GJS400 vertically split. The casing shall be manufactured using GJS400 cast iron, it will have a maximum continuous duty design temperature of 200oC, and a design pressure of 6.5 bar. The discharge flange shall be faced and drilled to ANSI B16.1, Class 125 pound.

B. The gear drive housing shall be of superior grade nodular cast ion, GJS 400, or close-grained cast iron ASTM A48, Class 30B, vertically split and sufficiently rigid to maintain the shaft positions under maximum loads. Horizontally split gearboxes shall not be allowed.

2.4 IMPELLERS

A. The impeller shall be of the open radial flow type, with backward leaning blades and milled from forged aluminum alloy. Impellors shall be anodized. Impellers constructed of any other method or material shall not be acceptable. The impeller must withstand corrosion up to 10 ppm of H2S. The impeller shall be attached to the shaft by interference fit arrangement. The impeller shall be statically and dynamically balanced.

2.5 VARIABLE VANES

A. The purpose of the inlet guide vane and variable discharge diffuser system shall be to facilitate turndown of each blower from 100% to 40% of capacity, while maximizing efficiency over the entire turndown range.

B. An adjustable inlet guide vane assembly shall be provided to pre-rotate incoming air and, thus, maximize efficiency. Inlet guide vanes shall be made in an aerodynamic, streamlined design in cross-section and located in a radial fashion around the annular inlet. Inlet guide vane position shall be controlled by the efficiency optimization software matrix from the LCP.

C. The inlet guide vanes shall modulate simultaneously with the diffuser vanes to continuously optimize efficiency based on the three variables of inlet temperature, differential pressure, and machine capacity. The Manufacturer shall demonstrate, in submittals and testing, the simultaneous efficiency optimization based on these three variables. Step control of vanes for efficiency optimization or control using less than these three variables shall not be acceptable.

D. Variable discharge diffuser vanes shall be provided for capacity control and designed to obtain the highest efficiency over the entire regulating range. Vanes shall be aerodynamically shaped for maximizing efficiency.

E. Flat steel plates shall not be used for inlet guide vanes or the variable diffuser vanes. Each inlet guide vane or variable diffuser vane shall be machined from a solid piece of metal. Vanes which are held to their respective shafts by screws are unacceptable.

F. The inlet guide vane and the variable diffuser assemblies shall be mounted integrally with each blower, multi-leaf and pivoted, and located in cast or ductile iron housings. Diffuser vanes shall be mounted in permanently lubricated sleeve bearings. Operating linkages for inlet guide vanes and variable diffusers shall be housed within the blower. Access to the operating linkages shall be made without the need to remove the impeller and pinion shaft. Blowers with variable vane assemblies located external to the blower housing, and/or have ball-in-socket linkages or other moving parts requiring periodic lubrication shall not be acceptable.

G. Each variable vane assembly shall include a skid mounted electric actuator, limit switches, and open/closed indication on the LCP. Independent floor mounting of the actuator or its operating mechanisms shall not be allowed.

H. The position of each set of vanes, from fully open to fully closed, shall be transmitted to the LCP via an analog signal. Position of both sets of vanes shall be indicated by an adjustable manual lever arm and calibrated dial on the blower, per se. The inlet guide vane, and the diffuser vane position shall be indicated on the LCP.

I. Inlet guide vanes, variable diffuser vanes, and diffuser guide vane back plate shall be 316 stainless steel.

2.6 SHAFTS, GEARS AND SEALS

A. The blower gear shafts shall be machined from heat-treated, forged steel and suitably ground. Any responsive lateral critical speed of the rotating assembly shall be at least fifteen (15) percent from the normal operating speed. Any torsional resonances of the package shall be at least ten (10) percent from the normal operating speed.

B. The speed-increasing, helical, parallel shaft type gears shall be made of case-hardened alloy steel forgings with the gear teeth precision ground. All gears shall be rated in accordance with “Fundamental Rating Factors and Calculation Methods for Involute Spur and Helical Gear Teeth” The gears shall be manufactured to a minimum AGMA quality number of twelve (12) per “Gear Classification and Inspection Handbook”.

C. The shaft seals shall be of a non-contact, multi-point, non-wearing labyrinth type and operated dry. A vented space between air and oil seals shall be provided. Any leakage shall be minimized by having small clearances between female and male parts. The female part shall be made of aluminum or bronze to avoid damage to the shaft in the event of a seal rub. Numerous slinger rings (diameter changes) on the shaft shall be provided in the sealing area to ensure oil is centrifugally slung off the shaft. Uniform shaft diameter without multiple slinger rings in each sealing area will not be acceptable.

D. All bearings shall be of alloy steel construction. Bronzed backed bearing shall not be allowed. Drive shaft radial bearings shall be cylindrical, journal type. Drive shaft thrust bearings shall be multiple segment designed for thrust in both directions. Antifriction ball bearings shall not be allowed on the drive shaft. Pinion shaft radial bearings shall be steel backed tilting pad bearing for optimum rotor stability and the pads babbitted. The bearings shall be designed to suppress hydrodynamic instabilities and provide sufficient dampening to limit rotor vibrations. Fix geometry cylindrical sleeve journal bearings and/or antifriction ball bearings shall not be allowed on the pinion shaft. Pinion shaft thrust bearings shall be multiple segment, tapered land type and designed for thrust in both directions. Radial and thrust bearings shall be pressure lubricated with sufficient oil film thickness under all operating conditions. Steel ball bearings or ceramic ball type bearings shall not acceptable for the pinion shaft.

2.7 OIL LUBRICATION SYSTEM

A. A lube oil system shall be provided with each blower, installed integral with the blower skid. A gearbox shaft-driven oil pump shall supply lubrication for the air blower/gearbox. The oil reservoir shall be integral to the gearbox or base.

B. The oil filter shall be of the full flow, replaceable cartridge type, capable of removing particles over 10 microns with a clean oil filter pressure drop not exceeding 15 psi at design temperature and flow. A visual gauge shall indicate when a filter is dirty and requires cleaning.

C. Provide an air-to-oil to maintain constant oil temperature, mounted on each blower skid.

2.8 COUPLING

A. A flexible, jaw type coupling shall be furnished to connect the blower and motor. Coupling and spacer shall be balanced to AGMA, Class 8, or better, and sized with a minimum service factor of 1.5. Coupling construction shall be such that either shaft of the unit may be removed without disturbing adjustment of the other. An OSHA approved steel guard shall be provided and installed over the coupling.

B. Flexible, forged steel, double-disc, dry type couplings may also be used provided that the manufacturer has selected the coupling for the specific installation requirements and environment.

2.9 EQUIPMENT BASE AND MOUNTINGS

A. The Manufacturer shall furnish a base of adequate size to support the blower, gearbox, motor, and accessories. The units shall be factory aligned on the base prior to shipment. Furnish vibration isolators designed for a transmissibility of less than 2%.

2.10 ELECTRIC MOTORS

A. Motors shall be provided per Specification 16220, Low Voltage Motors.

B. Each blower shall be provided with a horizontal, constant speed, TEFC, squirrel cage induction motor designed in accordance with current NEMA, ANSI and IEEE standards. The motor horsepower shall be equal to, or in excess of, maximum normal load that will be imposed at any point in the operating range of the design conditions specified. Each motor shall have a 1.15 service factor with Class “B” insulation. Each motor shall be premium efficiency, balanced for reduced vibration and supplied with lifting lugs, high temperature therrmostats, and space heaters as specified in 16220.

C. Motors shall be premium efficiency design per Section 16220, Low Voltage Motors. Efficiencies shall be determined in accordance with NEMA Standard MGI-12.53a and IEEE Standard 112, Test Method B. Nominal and guaranteed efficiencies shall be included on motor nameplates in compliance with NEMA Standard MGI-12.53b.

D. All motors shall be suitable for operation on 460/60/3 power for ambient air temperature greater than 105 F. Motors shall be suitable for reduced voltage solid state start.

2.11 INLET FILTER / SILENCER

A. Each blower shall be provided with an inlet filter/silencer designed for maximum air flow at absolute minimum pressure drop, and connected directly to the inlet of the blower via a flexible connector. Legs shall be adjustable for vertical positioning and leveling.

B. The filter elements shall be rectangular and replaceable. The coarse pre-filter shall have a removal efficiency of 93% on 10 micron. The final filter element shall have a rating of Merv 8 or better. The filters shall be sized for a maximum face velocity of 575 feet/minute at peak air flow.

C. Maximum clean filter pressure drop of the inlet filter/silencer with the elements installed shall be 2.5 in. w.c. (0.09 psig). Maximum pressure drop with dirty inlet filters shall be 4.2 inch w.c. (0.15 psig).

2.12 DISCHARGE EXPANSION JOINT

A. Unless otherwise noted, pipe, connection and accessory components shall be provided by the Manufacturer in accordance with:

1. Section 15000 – Piping General

B. Provide each blower with a discharge expansion joint, for field installation by the Contractor, capable of withstanding the vacuum, pressure, and high discharge air temperature under all operating conditions. The expansion joint shall be suitable for mounting between flanges drilled for standard ANSI 150 pound pattern.

2.13 DISCHARGE CONE / SILENCER

A. Provide a discharge cone/silencer (Evasé stack), for field installation by the Contactor, to increase the blower outlet size to the larger diameter air discharge piping. Maximum sidewall angle increase shall be 7-deg per side (14-deg total). Sidewall angle may be shortened to accommodate height restraints in the discharge piping arrangement, pending Engineer approval. Instrument connections shall be provided, for components mounted by the Contractor, on the cone/silencer. The inside of the discharge cone/silencer shall be lined with deep layers of sound absorbing material, resistant to high temperatures.

2.14 BLOW-OFF (BYPASS) VALVE

A. Unless otherwise noted, valve and accessory components shall be provided by the Manufacturer in accordance with:

1. Section 13446 – Electrical Operators for Valves and Gates

2. Section 15200 – Valves General

3. Section 15201 – Valve and Gate Actuators

4. Section 15214 – Pressure Control Valves

5. Section 15203 – Check Valves

6. Section 15230 – Miscellaneous Valves

7. Section 15214 – Pressure Control Valves

B. Provide each blower with a steel or cast iron body blow-off wafer type butterfly valve for field installation and wiring to the LCP by the Contractor to allow unloaded start-up and stop.

C. The valve operator shall be motorized, 120V/60/1 powered from the LCP, NEMA 4, open/close in fifteen (15) seconds or less, equipped as specified in Section 13446 with starter, open/close limit switches, and shall be suitable for air service up to 250 F.

D. Remote controls for the valve shall be mounted in each LCP with indicator lights to annunciate fully open or closed.

E. Bolting and gaskets shall be provided by the Contractor.

2.15 BLOW-OFF SILENCER

A. A carbon steel blow-off silencer shall be provided for each blower. The blow-off silencer shall be an integral unit, fitted with one (1) flange for direct bolting to the blow-off valve, with installation by the Contractor. The silencer will be externally mounted off the discharge.

2.16 DISCHARGE ISOLATION VALVE

A. Unless otherwise noted, valve and accessory components shall be provided by the Manufacturer in accordance with:

1. Section 13446 – Electrical Operators for Valves and Gates
2. Section 15200 – Valves General
3. Section 15201 – Valve and Gate Actuators
4. Section 15214 – Pressure Control Valves
5. Section 15203 – Check Valves
6. Section 15230 – Miscellaneous Valves
7. Section 15214 – Pressure Control Valves

B. Provide each blower with an actuated wafer type discharge butterfly valve for field installation and wiring to the LCP by the Contractor, identical to the blow-off valve, except for size and actuation speed, which shall open/close no faster than thirty (30) seconds.

2.17 CHECK VALVE

A. Unless otherwise noted, valve and accessory components shall be provided by the Manufacturer in accordance with:

1. Section 15200 – Valves General
2. Section 15201 – Valve and Gate Actuators
3. Section 15203 – Check Valves
4. Section 15230 – Miscellaneous Valves
5. Section 15214 – Pressure Control Valves

B. Provide each blower with a wafer type discharge check valve of the dual, plate type with center hinge, spring closure, cast iron body, Viton-B seal and aluminum-bronze plates, Inkonel springs, and rated for temperatures up to 400°F.

C. The check valve shall be mounted and installed by the Contractor, in a horizontal run of piping, as shown on the drawings.

2.18 INLET AIR LOUVER ADAPTER

A. Unless otherwise noted, air handling accessory components shall be provided by the Manufacturer in accordance with:

1. Section 15500 – Heating, Ventilating, and Air Conditioning

B. Provide an adapter kit or cowling transition assembly for each blower to transition from the blower package inlet filter/silencer and to the dedicated wall louvers for inlet air, as shown on the drawings.

C. Adapter kit shall be designed to be detachable from the blower package inlet filter/silencer and wall louver. Adapter shall have adjustable support legs for vertical positioning and self-supporting.

D. Louver shall be sized per the Blower Manufacturer's requirements for inlet air velocity to the inlet filter/silencer, a minimum of 700 feet/minute, and confirmed by the HVAC and Architectural Engineer.

E. Louver minimum size shall be 48" x 48".

F. Adapter kit to be fabricated of similar materials as the inlet filter/silencer.

2.19 BLOWER INSTRUMENTATION

A. Instrumentation in this section is to be provided as part of the packaged system and can be per the typical standard supply make and manufacturer for the BLOWER SYSTEM SUPPLIERS standard scope of supply.

B. These components shall be mounted on the blower skid, except as noted, with all electrical connections external to the skid, brought to the skid-mounted LCP, by the Contractor.

C. Unless otherwise noted, Instrumentation components shall be provided by the Manufacturer in accordance with:

1. Section 13400, Common Work Results Process Instrumentation and Controls

2. Section 13431, Instrumentation and Controls – Analytical Devices

3. Section 13432, Instrumentation and Controls – Flow Measurement

4. Section 13433, Instrumentation and Controls – Level Measurement

5. Section 13434, Instrumentation and Controls – Pressure Measurement

6. Section 13435, Instrumentation and Controls – Temperature Measurement

D. Instrumentation for each blower shall include, as a minimum:

1. Inlet air filter differential pressure combination switch gauge (installed on the filter housing and wired to the LCP by the Contractor)

2. Inlet air temperature gauge

3. Inlet air temperature transmitter, 4-20 mA

4. Pressure switch High (Surge switch)

5. Differential pressure (inlet/discharge) transmitter, 4-20 mA (1/4 inch tubing between the transmitter and the discharge cone provided by and installed by the Contractor)

6. Inlet guide vane position transmitter, 4-20 mA, position indicator gauge, open limit switch, closed limit switch

7. Variable outlet diffuser position transmitter, 4-20 mA, position indicator gauge, open limit switch, closed limit switch

8. Blow-off valve limit switches (integral with blow-off valve actuator and wired to the LCP by the Contractor)

9. Discharge temperature transmitter, 4-20 mA

10. Discharge air pressure gauge (installed by the Contractor)

11. Discharge valve limit switches (integral with discharge valve actuator and wired to the LCP by the Contractor)

12. Oil level indicator gauge

13. Oil filter differential pressure indicator gauge across the oil filter

14. Oil pressure switch High

15. Oil temperature transmitter, 4-20 mA

16. Oil pressure transmitter, 4-20 mA

17. Oil temperature indicator gauge

18. Oil pressure indicator gauge

19. Oil pressure switch Low

20. Motor temperature switch High

21. Bearing temperature elements (4)

22. Vibration switch

2.20 LOCAL CONTROL PANEL (LCP)

A. Each blower shall be furnished with a skid-mounted PLC-based sequencing panel. All controls and instruments shall fail into a safe condition. The controls shall be designed such that the blower cannot operate unless the controls are energized, nor can they operate with any defective controls.

B. The NEMA 12 rated enclosure shall be mounted on the blower skid, and fitted with a hinged door for front access. The Contractor shall provide and wire the 120/60/1, 30

amp power supply. Each assembled control panel shall carry a UL label certifying the assembled industrial control panel complies with UL 508 and with other requirements of Section 11000.

C. Each blower LCP shall contain controls for blower motor starting commands, surge and overload detection, shutdown control and sequencing, alarm and emergency shutdown systems, inlet guide vanes, variable diffuser vanes, discharge valve, bypass valve, and the oil lubrication system operation.

D. Each LCP shall contain a main power disconnect, which interlocks the enclosure door. Motor starters conforming to NEC requirements for variable vane operators (air/oil cooler, if applicable) and oil pump (if applicable) shall be mounted inside the panel. Provide for power distribution to feed motorized valve motor controllers located at the valves. Provide a separate 24V DC regulated power supply. Isolate all low voltage variable power signals entering the LCP. Soft starter for the main drive motor is located in the adjacent Electrical Control room, and provided under Section 16265.

E. A Modicon M340 PLC per Section 11000 shall start and shut down the blower in a permissive sequence, receive input, monitor and control operating variables. The PLC shall also contain a program for continuous optimization of blower efficiency with respect to changes in capacity, inlet temperature, and differential pressure across the blower.

F. Identify each end of each wire by a unique wire number printed on a heat shrunk sleeve marker.

G. Provide an Operator Interface touch sensitive, HMI screen that incorporates all controls, alarms, and meters in easy-to-interpret color screens. Operator Interface shall have a color, 7-inch screen minimum. Screen configuration shall match color conventions and operational look-and-feel with the existing plant control system as specified in Section 13400.

H. The operating screens (pages) shall be custom tailored to provide not only start-stop and operational mode interface, but also alarm status, and diagnostics. The following general design protocol shall be incorporated:

1. When an alarm occurs, it is displayed on all screens, and a message screen appears to identify the problem.

I. Provide touch sensitive screen point control via the Operator Interface screens, status indication, and readout for the following functions.

1. Start blower

2. Stop blower

3. Local control

4. Remote/Auto control

5. Open blow-off valve

6. Close blow-off valve

7. Open discharge valve

8. Close discharge valve

9. Open variable diffuser vane

10. Close variable diffuser vane

11. Open inlet guide vane

12. Close inlet guide vane

13. Low oil pressure indicator

14. High oil temperature indicator

15. Surge control indicator

16. Inlet air high temperature (recirculation surge) indicator

17. Inlet air filter high differential pressure indicator

18. High vibration indicator

19. General alarm indicator

20. Global alarm reset

J. Additional selector switches, pushbuttons, and indicators shall include:

1. Service/Normal/Test – Located on the Operator Interface. This touch sensitive screen point allows permissive start of the blower components only in the Service Mode. When in Test Mode, this diverts RVSS start signal to test logic that simulates motor start to facilitate testing of the system without starting the drive motor.

2. Emergency stop mushroom button on panel door

3. Separate, non-resettable hour meter on panel door

K. Indication of all analog signals with high and low alarm setpoints shall be displayed on the Operator Interface, including, but not limited to:

1. Motor amps

2. Variable diffuser vane position (40-100 percent capacity)

3. Inlet guide vane position

4. Temperature signals

5. Pressure signals

L. The blowers shall start under an automatic sequence initiated by the local start signal or the remote start signal when in remote/auto control. Upon signal to start, the PLC shall

confirm that the inlet guide vanes and variable diffuser vanes are at minimum, the blow-off (bypass) valve is open, and the discharge valve is closed. All vanes and valves shall be equipped with limit switches on both the open and closed position to indicate position. If components are not properly positioned, they shall move to their respective start positions automatically via the PLC logic.

1. Once all pre-start permissives are confirmed, the blower motor shall be started. A feedback signal from the RVSS (Section 16265) shall confirm that the main drive motor starter has been energized. When the blower reaches operating speed, as determined by the motor start sequence, the PLC shall open the inlet guide vanes and discharge valve, close the blow-off (bypass) valve, and release control of the inlet guide vanes and variable diffuser vanes to local/remote control. If the components are not correctly positioned, interlocks shall be provided to prevent blower operation after the delay time during start-up. Provide sequence fail alarm and trip if any portion of the start, run, or stop sequence is not properly executed. The Operator Interface shall annunciate the alarm condition that caused the shutdown.

2. The Pre-Start

M. The surge detection system shall sense unbalanced/surge conditions by use of pressure sensing devices. Detection of surge conditions shall trip the blower off-line.

N. Motor overload protection software shall be provided to control the maximum vane setting on the blower, so that motor current does not exceed a pre-set level.

O. There shall be three means of shutting down the blower:

1. Normal Stop - Initiated by pushing the stop button or remote stop. The unit normally stops such that no surging occurs.

2. Soft Stop – Initiated by:

   a. High oil temperature
   b. High inlet air temperature (recirculation/surge)
   c. Discharge valve has not fully opened within two (2) minutes (Operator adjustable, initial setpoint to be adjusted during startup and commissioning) after receiving feedback signal from RVSS
   d. Blow-off valve has not closed within five (5) minutes after receiving feedback signal from RVSS
   e. Surge
   f. Soft stop shall de-energize the main drive motor after an adjustable time period (initially set at eight (8) seconds after alarm initiation) to allow the blow-off valve to partially open.

3. Emergency Stop – Initiated by:

   a. Pushing emergency stop button
   b. Low-low oil pressure
   c. High vibration
   d. No feedback signal from RVSS during Start Sequence
   e. Motor current overload.
   f. RVSS failure.
   g. Loss of feedback signal from RVSS during Normal Operation

h. Sequence failure during start-up
i. PLC failure
j. Emergency stop shall de-energize the main drive motor immediately. Normal stop functions follow.

P. The blower shall have two types of Restart: Local and Remote.

1. Remote shall allow the blower to be restarted via the MCP and Plant SCADA or via auto-restart.

2. Alarms causing the blower shutdown must be cleared at the restart initiated locally from the LCP.

3. Loss of power is a permissive restart; alarm shutdown is not a permissive restart.

Q. The high inlet air temperature (recirculation) alarm shall be active when there is no main motor feedback present at the LCP from the RVSS. The purpose being to detect reverse air flow through the compressor.

R. Data communication shall be based on Modbus TCP, provided between the PLC's, located in each LCP, the MCP, and the plant control systems as shown on the Drawings. This compatible interface shall be as defined by the systems integrator specified under Section 13400; BLOWER SYSTEM SUPPLIER shall incorporate the requirements of the interface into each blower system PLC. The Contractor shall field wire all items between components, as follows:

S. Data communication to/from the LCP shall be as follows via PLC interface:

To MCP (Master Control Panel):

1. Blower on

2. Blower off

3. Common alarm

4. Control status – Local or remote/auto

5. Blower ready for start

6. Blower on

7. Maximum air flow

8. Minimum air flow

9. Common alarm

10. Blower in remote/auto

To and From RVSS – (Hardwired digital signals by the Contractor):

1. Motor start signal to RVSS (digital)

2. Run confirmation signal (digital feedback from RVSS)

3. RVSS alarm (digital)

4. Motor amps from RVSS (analog)

To and From Plant SCADA:

1. Interface between the MCP and Plant SCADA is per Specification 13550 Aeration Control System.

2. Plant SCADA Pre-Start and Operational permissives will determine if the MCP can initiate start of the blowers and aeration control system. Permissives will be ON/OFF selections by the Plant Operators:

   a. “Oxidation Ditch #1 Aeration System ON” – for OD #1
   b. “Oxidation Ditch #2 Aeration System ON” – for OD #2
   c. “Aeration Basin #3 Aeration System ON” – For AB #3
   d. “Aeration Basin #4 Aeration System ON” – For AB #4

2.21 OTHER REQUIREMENTS

A. Equipment specified in this Section shall be controlled by PLC-based controls located in the skid-mounted LCP and MCP remotely locate in the adjacent Electrical Control room, as shown on the drawings. Provide devices and interfaces as required to accomplish the functions described. Coordinate with the starter supplier for interface details to and from the RVSS equipment provided under Section 16265.

B. Provide interconnection schematics, loop diagrams and control schematics for wiring required between MCP, LCP, RVSS, and field equipment (valves, instruments, and ancillary equipment) for the conduit and wire as required under Section 16000. The Supplier specified in this section shall obtain the necessary equipment terminal block information for all equipment and prepare the interconnection and loop wiring documentation for all wiring required for the Blower system.

C. The controls provided under this Section shall protect the equipment provided. The BLOWER SYSTEM SUPPLIER shall submit documentation stating that the equipment is protected by the controls furnished under this Section. Any out of range conditions which could occur under remote control and cause damage shall be described and suitable mitigation measures identified.

2.22 FACTORY TESTING

A. Testing shall be in accordance with Section 11500 Blowers, Compressors, Vacuum Pumps, General.

B. Each motor shall be given a standard, short commercial, non-witnessed test in accordance with IEEE test procedures. A certified motor data sheet shall be furnished for approval prior to shipment.

C. Each blower shall be tested in accordance with the ASME Power Test Code for Centrifugal Compressors and Exhausters, PTC-10-1997 or ISO 5389-2005.

   1. Tests may be conducted using the job motor or a factory test motor. Testing with job motor as complete assembly shall be preferable. In either case, a calibrated

torque meter or heat balance test shall measure the compressor shaft input horsepower as per Paragraph 4.35 of the Code.

2. The test shall include determination of the surge point and verification of the guarantee points. Compressor net delivered flow rate and discharge pressure shall be guaranteed with no negative tolerance. There shall be no other tolerances or measuring uncertainties used in reporting test results (i.e., the tests shall be reported with ± 4 percent tolerance).

3. The witnessing Owner representative shall sign each copy of the test data log sheet certifying that the required tests were performed in strict accordance with these Specifications and the ASME PTC-10/ISO 5389 Codes, specifically Paragraph 4.35, Torque Meter Tests.

4. The capacity of the blower shall be defined as per Paragraph 4.26 of the ASME PTC-10 Power Test Code. Specifically, capacity is defined as, “the net rate of flow compressed and delivered, expressed in terms of cubic feet per minute at the prevailing inlet temperature and pressure. It shall be measured in a suitable manner to exclude effectively all external leakage losses from sources such as shaft seals. That is, air flow shall be measured on the discharge flange of the compressor at zero percent tolerance.

5. All test equipment shall be calibrated and certified by an independent test agency no more than 12 months prior to the test date. Certificates shall show the stability of calibration over a period of at least 1 year per ISO 9001, Paragraph 4.11.

6. Velocity vibration versus frequency levels shall be recorded within 10-1,000 and 10-10,000 Hz frequency range.

D. Upon completion of the ASME PTC 10/ISO 5389 Factory Performance Test, perform system testing with at least one blower, all four local control panels and the master control panel, using simulated aeration basin DO level signals and recording simulated reaction of blower staging, blower capacity, and basin valve/blow-off valve position.

E. All blower ASME PTC-10/ISO 5389 tests and the complete assembly tests shall be witnessed by representatives of the OWNER at the OWNER’s expense, if requested by Owner.

1. Provide 21 days prior notice, in writing, for the witnessing of tests.

2. At the OWNER’s option, the ASME PTC 10/ISO 5389 test may be witnessed by an independent test agency. The costs of these tests shall also be included in the blower equipment price.

F. The blower test report shall present computations in exact accordance with Sections 5, 6, and 7 of ASME PTC-10/ISO 5389 Code with performance curves showing capacity, pressure, and horsepower inputs.

G. Test results of the motors and blowers shall be included in the Operations and Maintenance Manual.

H. In the event that results of the Total Factored Power Draw do not meet the specified Total Factored Power Draw as provided by the BLOWER SYSTEM SUPPLIER’s bid, the units shall be re-worked and re tested at no additional cost to the OWNER, until

they comply with the Total Factored Power Draw as provided by the BLOWER SYSTEM SUPPLIER's bid.

1. The Total Factored Power Draw will be calculated using the results of the PTC-10/ISO 5389 test for blower horsepower, factory tested motor full load efficiency, and the ancillary power requirements, if any, as tested by the electrical acceptance test described in the Specifications.

2. Alternatively, the OWNER may accept the blowers by imposing a power penalty of $14,775 per horsepower, per blower in excess of the guaranteed Total Factored Power Draw. The penalties shall be calculated to the nearest rounded horsepower, for each blower, and deducted from payments to the CONTRACTOR for the work performed. A credit will not be allowed for any blower (tested) Total Factored Power Draw that is under that guaranteed.

2.23 CONTROL PANEL DESIGN AND TESTING

A. The LCP design, construction, and testing shall be performed by the BLOWER SYSTEM SUPPLIER or Subcontractor to ensure quality assurance, control, and testing by the in an UL C508 certified shop. This testing in the BLOWER SYSTEM SUPPLIER or Subcontractor shop shall be completed as specified in this Specification section and as required under Section 11000, Equipment General Provisions.

2.24 SPARE PARTS

A. Each blower shall be supplied with the following spare parts:

1. One complete set of all bearings

2. One complete set of o-rings, gaskets, and seals

3. One set of oil filter cartridges

4. One set of oil breather cartridges

5. One set of primary inlet air filters

B. Supply the following common spare parts:

1. One actuator for inlet guide vanes

2. One actuator for variable diffuser vanes

2.25 MANUFACTURERS

A. Unit Responsibility: The blower system specified herein and the Aeration Package System as specified under Specification 13550, shall be provided by a single BLOWER SYSTEM SUPPLIER who shall be responsible for the entire system performance and compatibility.

B. The listing of any Manufacturer by name shall not imply tacit approval of same. The selected Manufacturer shall be required to meet the specifications. Equipment which is a "standard product" with the Manufacturer shall be modified, re-designed from the standard mode, if necessary, or furnished with special features, accessories, materials,

or finishes as may be necessary to conform to the detailed requirements of these specifications and contract drawings.

C. Manufacturers may have varying requirements for system connections, mounting, controls, clearances and other details. It shall be the Contractor's responsibility to modify details of blow mounting, connections, etc., to suit the equipment selected for the Project, at no additional cost to the Owner.

D. BLOWER SYSTEM SUPPLIER:

1. Next Turbo Americas, LLC

2. Lone Star Blower

3. Howden (Turblex)

4. Or Approved Equal

PART 3 EXECUTION

3.1 GENERAL

A. Execution including delivery and storage, installation, testing, and other applicable execution requirements shall be in accordance with Section 11500 Blowers, Compressors, Vacuum Pumps, General and Section 11000 Equipment General Provisions. Additional execution requirements shall apply as specified herein and as specified in referenced Sections.

3.2 DELIVERY AND STORAGE

A. A complete set of manufacturer's instructions covering storage, installation, operation, lubrication, and maintenance shall be furnished to the OWNER no later than the date the equipment is shipped. Care during storage and procedures for installation, lubrication, and startup of the equipment and motors shall be in strict conformance with the manufacturer's instructions.

B. All equipment shall be skid mounted or crated to protect against damage during shipment. All parts shall be properly protected so that no damage or deterioration will occur during a prolonged delay from the time of shipment until installation is completed, and the units and equipment are ready for operation.

C. Finished surfaces of all exposed flanges shall be protected by fiberboard blank flanges strongly built and securely bolted thereto.

D. Shipment is not to be made until the Manufacturer coordinates shipment to the jobsite with the Contractor, assuring that the equipment will be properly received and stored.

E. Upon receipt, store equipment in strict accordance with the Manufacturer's instructions, and connect and energize motor space heaters (and any other protective devices), as required.

3.3 INSTALLATION

A. The blowers, motors, all aeration instrumentation, and appurtenances shall be installed by the CONTRACTOR in accordance with the instructions of the Manufacturer and as shown on the drawings. All piping shall be supported so as to preclude the possibility of exerting undue forces and movements on the blower flanges. Each blower unit shall be mounted on a flat and level concrete pad or level floor (± 1/4 inch) in accordance with the recommendations of the Manufacturer.

B. The CONTRACTOR shall furnish the required piping, pipe supports, flange gaskets, bolts, nuts, oil, and grease for initial operation in accordance with the Manufacturer's recommendations

3.4 COMMISSIONING, STARTUP AND TRAINING

A. Start-up and training shall be completed by the BLOWER SYSTEM SUPPLIER for the complete blower package and aeration control system. System control testing shall be per Section 11000, Equipment General Provisions.

B. The BLOWER SYSTEM SUPPLIER shall furnish experienced start-up/service personnel provide installation guidance and inspection, commissioning, startup-up and training per the minimum durations indicated in Section 1.5 of this specification.

C. The main air header pressure transmitter, DO probe transmitters, air flowmeters, and air flow control valves shall all be started-up, and the system optimized for automatic, unattended operation. The BLOWER SYSTEM SUPPLIER shall coordinate to have the Manufacturer's certified technicians for these components present for tuning and final calibration.

D. System time lags, speed of valve operation, fine tuning of control loops, and overall time lags shall all be initially set and then optimized based on plant conditions. The entire system of aeration blowers, main air header pressure control, most open valve control, and overall aeration system automated operation shall be demonstrated to the satisfaction of the Engineer.

3.5 PERFORMANCE TESTING

A. The BLOWER SYSTEM SUPPLIER shall furnish an experienced service representative to inspect the final installation and supervise the field acceptance tests of the equipment. The services of the representative shall be as listed in this specification. If there are difficulties in operation of the equipment due to the BLOWER SYSTEM SUPPLIER's fabrication or CONTRACTOR's installation, additional service shall be provided at no extra cost to the OWNER until problems are resolved. Performance testing shall be coordinated with the testing requirements of Specification 13550.

1. Provide, as a minimum, the following field services:

    a. Verify proper connection of piping and installation of accessories.
    b. Field precision alignment of the motor, blower, and coupling.
    c. Check leveling of blower base.
    d. Confirm proper wiring of all instruments and field wired items.
    e. Run motor uncoupled for up to 1/2 hour to verify motor operation and check magnetic center for proper marking/location.

2. A minimum 8 hour field acceptance test shall demonstrate that, under all conditions of operation, each unit:

   a. Has not been damaged by transportation or installation.
   b. Has been properly installed.
   c. Has no mechanical defects.
   d. Has fully functional instrumentation which is properly calibrated and set.
   e. Will start, run, and stop in the prescribed manner.
   f. Will run through the entire range of specified pressure and flow.
   g. Has the proper shutdown sequence of standard stop, soft stop, and emergency stop.
   h. Is free of overheating of any parts.
   i. Is free of objectionable vibration and noise.
   j. Is free of overloading of any parts.

B. Field acceptance testing shall be conducted after the installation of all equipment has been completed and the equipment has operated for a sufficient period to make all desirable corrections and adjustments. The CONTRACTOR shall schedule testing with the full knowledge and consent of the OWNER and shall ensure no adverse affect on the operation of plant facilities.

C. Electrical Acceptance Test: Verification of provided guaranteed power consumption shall be documented by electrical acceptance testing. This acceptance testing is separate and independent from the Performance Testing described above, but may be conducted concurrently.

1. Electrical acceptance test shall consist of an 8 hour consecutive measurement of kW usage and power factor on the BLOWER SYSTEM by the BLOWER SYSTEM SUPPLIER and CONTRACTOR and verified by OWNER's representative. A record of electrical power usage shall be available to the BLOWER SYSTEM SUPPLIER upon conclusion of the 8 hour acceptance test.

2. Test Protocol: The Blowers System shall be operated at conditions as required in this specification. During this acceptance test, the power consumption and power factor shall be measured at each design point and recorded using a watt-hour meter and power factor meter to be supplied by the CONTRACTOR. The meters shall provide accuracy of +/- 0.25 percent, shall operate at frequencies between 47 to 63 Hz, and shall be furnished with a statement from the meter supplier verifying its accuracy. The meters shall be connected to the line side of the motor starter and shall provide continuous recording of data. In the event that specified temperature and humidity cannot be practically replicated in the field, the BLOWER SYSTEM SUPPLIER shall provide calculations that calibrate the electrical acceptance test horsepower to the horsepower at the temperatures and humidity specified.

END OF SECTION

SECTION 11503 – POSITIVE DISPLACEMENT BLOWERS

PART 1 GENERAL

1.1 THE REQUIREMENT

A. The CONTRACTOR shall furnish and install (1) one positive displacement blower for scum pit service at RAS Pump Station North and (2) two positive displacement blowers at the WAS Storage Tanks and all appurtenant work, complete and operable, with all necessary accessories, tools, drives, piping, fittings, valves, connectors, safety devices, controls, and spare parts to obtain a workable installation suitable for continuous operation 24 hours per day, as shown and specified herein, in accordance with the requirements of the Contract Documents.

1.2 REFERENCE SPECIFICATIONS, CODES, AND STANDARDS

A. The reference specification, codes, and standards of Section 11500, Blowers, Compressors, Vacuum Pumps, General apply to this Section.

1.3 CONTRACTOR SUBMITTALS

A. General: CONTRACTOR shall submit administrative, shop drawings, samples, quality control, and contract closeout submittals of all equipment furnished this Section and in referenced Sections in accordance with the requirements of Section 01340 Shop Drawings, Product Data and Samples.

B. Shop Drawings and Samples: In addition to the requirements of Section 01340, CONTRACTOR shall submit the following:

1. Submittals in accordance with Section 11500, Blowers, Compressors, Vacuum Pumps General

2. Certified testing data indicating sound absorption and transmission loss characteristics of the noise enclosure assembly.

C. O & M Manuals: The CONTRACTOR shall provide operators and maintenance data for all equipment furnished for the project in accordance with Section 01730, Operation and Maintenance Data.

D. Tools: Special tools necessary for maintenance and repair of the equipment shall be furnished as a part of the WORK hereunder; such tools shall be suitably stored in metal tool boxes, and identified with the equipment number by means of stainless steel or solid plastic name tags attached to the box.

1.4 QUALITY ASSURANCE:

A. CONTRACTOR shall submit the following:

1. MANUFACTURER’s Certificate of Proper Installation

2. Functional Test Certification

3. Factory performance test reports

4. Special shipping, storage and protection, and handling instructions

5. MANUFACTURER's printed installation instructions

6. List of suggested spare parts to maintain the equipment in service for a period of 5 years. Include a list of special tools required for checking, testing, parts replacement, and maintenance.

7. List of special tools, materials, and supplies furnished with equipment for use prior to and during startup.

B. Warranty

1. A written suppliers warranty shall be provided for the equipment specified in this section as required in Section 11.2, General Conditions.

1.5 MANUFACTURERS SERVICE REPRESENTATIVE

A. MANUFACTURER's Representative. In accordance with the requirements of Section 01660, a MANUFACTURER's Representative shall be present at the site or classroom designated by the OWNER to provide the services and minimum person-days listed below, travel time excluded.

1. 2 person-days for installation assistance and inspection,

2. 1 person-days for functional and performance testing

3. 1 person-days for pre-startup training of OWNER's personnel.

PART 2 PRODUCTS

2.1 GENERAL

A. Equipment Requirements: Positive displacement blowers shall be of rotary, 2-lobe or 3-lobe, involute design with electric motor and belt drive, suitable for continuous operation 24-hours per day. All blowers shall be based upon data previously established by tests in accordance with ANSI/ASME PTC 9 Performance Test Code.

2.2 PERFORMANCE REQUIREMENTS

A. Operating Conditions: Positive displacement blower operating conditions shall be as follows:

Equipment Nos.	36-B-01-FA	51-B-01-AA 51-B-02-AA
Location	RAS Pump Station North	WAS Storage
Service	Scum Pit Air	WAS Storage Air
Elevation above sea (ft)	55	55

Capacity (cfm) at 14.7 psia and 68 degree F	42	1,620
Discharge pressure (psig)	6	8.5
Inlet temperature (degree F) max	100	100
Inlet temperature (degree F) min	20	20
Blower speed, max (rpm)	1,800	3150
Motor size min (hp)	5	100
Suction flange size (in)	4	8
Discharge flange size (in)	4	8
Flange rating (psi)	150	150

2.3 POSITIVE DISPLACEMENT BLOWERS

A. Rotor - The rotors shall be precision machined out of a one piece casting made of EN GGG 50 material. Stub shafts or two-piece impellers shall not be allowed

1. Cored rotors must be closed using threaded iron plugs which are permanently fixed. Impeller end caps of stamped sheet metal shall not be allowed.

2. The rotor assemblies shall be statically and dynamically balanced to ISO standard 1940/1- Q2.5 (turbine rotor). Modifications to the face of the rotors for balancing purposes are not acceptable.

B. Rotor Case: Shall be cast-iron, machined, and should include horizontal heavy rib reinforcement.

1. The casing shall be made of high strength, close grained, cast iron, and shall be adequately ribbed to prevent casing deflection and facilitate cooling. Casing shall be of EN GG 20 material.

2. The casing shall include threaded atmospheric vent ports between its air-side and oil-side labyrinth seals for safe separation of the conveying and oil chamber.

3. Inlet and discharge ports shall be drilled and tapped for studs to allow solid connection of mating surfaces. Through bolting shall not be allowed.

C. Drive:

1. Scum Pit: Drive shall be a V-belt-type with heavy-duty, constant speed, TEFC, high efficiency electric motor, suitable for indoor installation, in accordance with applicable requirements of Section 16220, Low Voltage Motors, for 480-volt, 3-phase, 60-Hz supply.

2. WAS Storage: IP55/ TEFC motor, inverter capable, EISA compliant, UL recognized. controlled motor (=>100HP) shall have an isolated non drive end “B-side” bearing.

   Methods of shaft insulation by means of brushes and/or grounding rings are not acceptable.

   a. The blower shall be driven by the drive motor through a V-belt drive assembly designed to meet the blower conditions specified with a 1.2 or larger service factor.
   b. V-belts shall have a XPZ/XPB profile with embedded low-stretch polyester tension cords. The v-belts shall be designed for high rotational speeds and be heat and oil resistance. Ribbed, banded, or multi groove belts shall not be allowed.
   c. Sheaves shall have a SPZ/SPB profile and be balanced to G16 for below 30m/s and G6.3 for sheaves above 30m/s.
   d. Keyed taper bushing shall be used for easy installation and removal. QD type bushings shall not be allowed.

D. Drive Shaft: Shall be extended steel stub shaft with coupling.

E. Bearings: Shall be anti-friction with thrust control, rated for a minimum L-10 life of 100,000 hours.

   1. All four rotor shaft support locations shall incorporate large, heavy-duty, full complement, cylindrical roller bearings with PEEK cages, designed with at least 5-times the dynamic capacity of ball bearings. Ball bearings shall not be allowed.

F. Headplates: Shall be cast iron, machined and ground internally to close tolerances.

G. Timing Gear: Shall be steel, accurately cut and bolted to the timing hub.

H. Lubrication: Shall be oil splash type from oil-tight housing. Drive-end bearings may be grease lubricated, with lip-type seals.

I. Base: Shall be heavy cast-iron or fabricated steel, common for the blower and motor. The motor shall be fitted with adjustable slide rails.

J. Belt Tensioning: Blowers shall have a swing motor base with automatic tensioning and tension indicator.

   1. The drive motor shall be mounted on a pivoting swing base with an axial adjustment for proper alignment of the v-belts. The weight of the drive motor shall provide the primary belt tension. The use of a sliding motor mount shall not be allowed.

   2. A tensioning assembly consisting of a threaded rod with spring shall be used to adjust the v-belt tension to prevent belt slippage and efficiently transmit power to the blower. It shall include a visual indication showing whether or not the v-belt tension is within the correct belt tension range.

   3. Adjustment of the tensioning assembly shall be accomplished without removal of the guard or loosening of the motor mounting bolts.

4. The design of the swing base with tensioning assembly shall prevent the swing base from falling and creating a personnel hazard in the event of a belt failure. The tensioning assembly adjusting nut shall raise the motor swing base facilitating v-belt changes without the use of pry bars or jacks

K. Expansion Joints: Shall be single arch with wire reinforced Dacron body with butyl tube and cover suitable for the operating air temperatures at the inlet and outlet. The discharge joint must include control rods.

L. Accessories: Each blower shall be furnished as a complete unit, with the following minimum accessories, all necessary pipes, fittings, supports, controls, and other components shown.

1. Air intake filter/silencer with support and disposable, industrial type, high efficiency filter elements. Silencers shall be the combination chamber/absorption type for maximum sound attenuation

2. Pressure differential indicator

3. Two stainless steel, braided, flanged flexible connectors not less than 9 inches long

4. Set of neoprene isolation isolator pads under each leg

5. Set of 316 Stainless Steel anchor bolts, nuts, and washers

6. Flanged discharge silencer

7. Pressure relief valve (weighted)

8. Pressure gauge with valve

9. Pressure switch

10. Discharge silent spring-loaded check valve

11. Discharge butterfly valve suitable for hot gases. Butterfly valves shall meet the requirements set forth in specification Section 15200, Valves, General. Valve actuators shall meet the requirements set forth in Specification Section 15201, Valve and Gate Operators and Section 13446, Electrical Operators for Valves and Gates.

12. Manually set unloaded start valve with 1.5psi close rate

13. Dedicated control system cooling fan independent of blower enclosure and blower cooling circuit

14. Cooling air circuit is separate from process air circuit and of honey comb design for short circuiting prevention

15. Oil level monitor

16. Separate ambient cooling inlet and enclosure air outlet

M. Motor: Shall be a belt drive with heavy-duty, constant speed, TEFC, high efficiency electric motor, suitable for indoor installation, in accordance with applicable requirements for 480-volt, 3-phase, 60-Hz supply.

N. Noise Enclosure: Provide a noise abatement enclosure for blower and blower motor, at a minimum, to limit maximum radiated sound levels. The maximum sound pressure level shall not exceed 80 db(A) free field at any point at a distance of 5 feet from the blower assembly. The enclosure shall be ventilated and shall have removable panels and hinged doors for easy access. The MANUFACTURER shall provide certified testing data indicating sound absorption and transmission loss characteristics of the panel assembly.

2.4 CONTROLS

A. Pump controls shall be supplied per the requirements of the applicable Sections of Division 13 and Section 11100 Pumps, General.

B. Equipment specified in this Section will be controlled by MCC-based controls with a local control station located in the blower building as shown on the drawings. Provide devices and interfaces as required to accomplish the functions described. Coordinate with the MCC supplier for interface details.

C. Interconnection schematics are required by Section 16442 – Motor Control Centers. The supplier of the systems specified in this section shall provide information and prepare documentation as required in the development and submission of the interconnection schematics.

D. Section 13421, Programmable Logic Controllers and Computer Control Systems includes requirements for submission of descriptions of out-of-range conditions which could damage equipment such as exceeding starts-per-hour limits. The controls provided under this Section shall protect the equipment provided. The supplier shall submit documentation stating that the equipment is protected by the controls furnished under this Section. For any out of range conditions which could occur when under remote control and cause damage, they shall be described in accordance with the requirements of Section 13421.

2.5 PROTECTIVE COATING

A. Shop and field painting shall be in accordance with requirements specified in Section 09900, Paintings and Coating.

2.6 MANUFACTURERS

A. Manufacturers or Approved Equal:

1. Roots (Dresser)

2. Sutorbilt (Gardner Denver)

3. Kaeser

PART 3 EXECUTION

A. General

1. Execution shall be in accordance with Section 11500 Blowers, Compressors, Vacuum Pumps, General.

3.2 DELIVERY AND STORAGE

A. A complete set of MANUFACTURER's instructions covering storage, installation, operation, lubrication, and maintenance shall be furnished to the OWNER no later than the date the equipment is shipped. Care during storage and procedures for installation, lubrication, and startup of the equipment and motors shall be in strict conformance with the MANUFACTURER's instructions.

3.3 INSTALLATION

A. Install in accordance with the MANUFACTURER's printed instructions.

3.4 TESTING

A. General: Testing shall be in accordance with Section 11500 Blowers, Compressors, Vacuum Pumps, General.

B. Noise Testing

1. All blowers shall receive a field performance noise test. The sound pressure level in dBA shall be measured at 5 feet horizontally from the surface of the blower enclosure on two sides and at the mid point of the blower enclosure height. Blower and motor shall not exceed 80 dBA.

END OF SECTION

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SECTION 11600 – BIOSOLIDS DRYER SYSTEM

PART 1 GENERAL

1.1 THE REQUIREMENT

A. This section covers a heat drying system to dry biosolids from the City of Brentwood Wastewater Treatment Plant. The drying system will be located in the Dryer Building. The dryer unit shall be a paddle type dryer system as provided by a single System Supplier experienced in these types of dryer systems. The drying system shall be furnished as a complete sludge dryer system including all equipment, materials and incidentals as required for a complete system and as described herein. Installation of the biosolids dryer system shall be provided by the System Supplier or by the Contractor. When installation is performed by the Contractor, the System Supplier shall be involved with the installation as required herein to provide a complete and properly functioning system.

B. The Work covered under this specification includes the design and fabrication of a complete thermal drying system, supply of materials, fabrication, and testing, for a complete and operable system with the performance capacities specified herein. Also included are installation supervision, commissioning, operator training, performance testing, and startup services, as specified herein. The work covered under this specification shall be provided by a single drying System Supplier which shall be responsible for the satisfactory operation of the complete drying system.

C. The drying system shown on the Drawings is based on the supply of the first-named supplier stated in Section 2.1, K, 3 – System Suppliers. The Drawings show a general depiction of the equipment and indicates a level of accessibility and clearances that shall be required for installation and maintenance of the dryer system components. The specific location of the sludge feed inlet, water supply and drain locations, discharge locations, and other dryer system connections and equipment will vary depending on the System Supplier. Additionally, the quantity of cooling conveyors, deflagration duct, aspiration air, and methods used for meeting the Contract requirements for safety may differ between what is provided by the System Suppliers and what is shown on the Contract Drawings. The supplied biosolids drying system shall fit within the building shown on the Drawings while maintaining the level of accessibility and clearances shown on the Drawings. If the Contractor selects a System Supplier other than the first-named System Supplier, Contractor shall be responsible for the cost of all modifications required to provide the accessibility and clearance requirements and modifications required of equipment that are tailored to the specific biosolids heat drying system design at no additional cost to the Owner. Such changes to the layout shall not impair the equipment accessibility or limit maintenance access as generally indicated on the Drawings, nor shall it relieve the System Supplier's responsibility for meeting the requirements of the Contract Documents. Any re-design of the Dryer Building structure, foundation, support utilities, or any other related infrastructure needed to accommodate other than the first-named supplier shall be borne by the Contractor, without additional cost to the Owner; any such re-design of related infrastructure shall be by the Owner's design engineer.

D. This specification identifies pressure and temperature ratings for various systems and equipment and these ratings shall be considered minimums. The System Supplier shall be responsible for providing higher ratings if required by their design.

E. The drying system shall include, but not be limited, to the following major items.

1. A dewatered sludge hopper, with two dewatered sludge pumps

2. A paddle dryer, including drive and heat transfer system

3. Thermal fluid heating system, including thermal fluid heater, fluid pump, fluid cooler, and expansion tank, including compliance with BAAQMD requirements.

4. Dried solids material handling system, including discharge screw conveyor, product cooling screw conveyor(s), screen, off-spec dried solids return screw conveyor, drag chain conveyor, and product loadout screw conveyor with telescoping loadout chutes.

5. Dryer off-gas condenser, particulate scrubber, fixed venturi, fan, and off-gas process ductwork between the dryer and condenser.

6. Dust collection system for telescoping loadout chutes and aspiration air from other dried solids equipment (if required by System Supplier), including wet scrubber and dust collection process ductwork upstream of the scrubber.

7. Explosion and fire prevention systems. If required by System Supplier's system, deflagration vents, deflagration duct, and deflagration deflector duct.

8. Access provisions from building floor to dryer equipment including, but not limited to, platforms, ladders, handrails, stairways, and all ancillary items.

9. Supports for equipment and process ductwork furnished under this specification to floors, foundations, and building. No component of the dryer system shall be supported from the building roof where conflicts with the bridge crane would be encountered.

10. Electrical equipment, including motors, motor starters, grounding and bonding, motor control centers (MCCs) and variable frequency drives (VFDs). "Hand-Off-Automatic" switches shall be provided for the sludge dryer VFD, pumps, and other motor controllers located in the Dryer System Supplier furnished MCC

11. Complete control system, including, but not limited to, all measuring elements, safety systems, control devices, signal converters, transmitters, control panels, programmable logic controllers (PLCs), field instruments – both electronic and mechanical, hardware, software, programming of software, communication networks, documentation, and all ancillary items required for a complete and operable system as specified in this Section and in Section 11000.

12. Dryer System Supplier shall provide grounding and bonding connections internal to and between components of the Dryer system as recommended by the System Supplier or as required by the NEC or other applicable NFPA requirements. Contractor shall provide equipment grounding conductors in raceways carrying equipment supply feeders and bond individual Dryer components to the ground grid system as shown on the Drawings and as required per Specification Section 16060.

13. All control valves, including, but not limited to, pneumatically operated valves solenoid valves, pressure regulating valves, pressure relief and vacuum relief valves.

14. Local instruments, including, but not limited to, level instruments, temperature gauges, and pressure gauges.

F. Equipment furnished under this section shall be fabricated, assembled, tested, and started up in full conformity with accepted shop drawings, specifications, engineering data, instructions, and recommendations of the System Supplier, unless exceptions are noted by the Owner or Engineer.

G. The system shall be furnished complete with all equipment supports, except as specified herein; all mechanical equipment required for proper operation, including complete drive units; all steel, iron, and other metal construction indicated by the shop drawings; all additional materials or construction required by the System Supplier's design; and installation assistance, field start up, testing and training as required by this specification and referenced specifications.

H. All equipment covered by the Biosolids Dryer System Specification shall be furnished by or through a single System Supplier. The System Supplier shall have responsibility for the design, coordination, and function of the systems. The System Supplier shall verify that each component of the biosolids heat dryer system is compatible with all other components of the system; that all pump, fan, motor sizes, and materials are appropriate; and that all devices necessary for a properly functioning system have been provided.

I. All work covered by this section shall be performed in accordance with all applicable local codes and ordinances, and laws and regulations of the State of California and the United States of America which pertain to this work. In case of conflict between these specifications and any law or municipal ordinance, the later shall govern.

J. All equipment furnished under this specification shall be provided in accordance with applicable specifications of the Contract Documents, including but not limited to:

1. 01060 Regulatory Requirements and Permits

2. 01340 Shop Drawings, Product Data and Samples

3. 01400 Quality Control

4. 01600 Materials and Equipment

5. 01612 Seismic Design Criteria

6. 01660 Testing and Training

7. 01720 Project Record Documents

8. 01730 Operation and Maintenance Data

9. 01740 Warranties and Bonds

10. 01750 Spare Parts and Maintenance Materials

11. 05120 Structural Steel

12. 05500 Miscellaneous Metals

13. 05510 Metal Stairs and Platforms

14. 05513 Metal Ladders and Accessories

15. 05520 Aluminum Handrails and Guardrails

16. 09900 Painting and Coatings

17. 10400 Identifying Devices

18. 11000 Equipment General Provisions

19. 13400 Common Work Results Process Instrumentation and Controls

20. 13420 Control Panels and Hardware

21. 13421 Programmable Logic Controllers and Computer Control Systems

22. 13482 Process Control Descriptions

23. 15050 Mechanical General Provisions

24. 15200 Valves, General

25. 15201 Valve and Gate Actuators

26. 16000 Common Work Results for Electrical

27. 16060 Grounding and Bonding for Electrical Systems

28. 16075 Electrical Identification

29. 16080 Electrical System Analyses and Commission Field Testing

30. 16145 Miscellaneous Electrical Equipment

31. 16220 Low Voltage Motors

32. 16260 – Low Voltage Variable Frequency Motor Controllers

33. 16442 Motor Control Centers

34. 16910 Fire Detection and Alarm Systems

K. Structural Design. Structural design, including access platforms, walkways, stairways, bins, tanks, deflagration duct supports and connections; and stacks, shall comply with the requirements specified herein.

1. Codes and Standards. The design and specification of all work shall comply with all applicable laws and regulations, with applicable local codes and ordinances, and with the codes and industry standards referenced in the following:

- The California Building Code (CBC), 2010 Edition.
- ASCE 7-05, Minimum Design Loads for Buildings and Other Structures.
- AISC 360-05: Specification for Structural Steel Buildings, 13th Edition.
- ANSI/AISC 341-05, Seismic Provisions for Structural Steel Buildings, including Supplement No.1 dated 2006.
- The Aluminum Association, Aluminum Design Manual 2005 Edition, "Specifications for Aluminum Structures."
- American Welding Society, Structural Welding Code for each type of welded Material.
- American Iron and Steel Institute, “Cold-Formed Steel Design Manual.”

2. General Structural Design Criteria. All elements of the project requiring structural design shall be designed, sealed, and signed by a Civil or Structural Engineer registered in the state of California.

3. Loads. Design loads for all structures shall be determined according to the criteria specified herein unless the applicable codes and standards or actual conditions require more severe design conditions.

   a. Dead Loads. Dead loads shall consist of the weight of the structure and all equipment of a permanent or semi-permanent nature including tanks, silos, bins, piping, ductwork, lighting, bus ducts, and the contents of tanks, silos, bins, and hoppers measured at full capacity.

   b. Live Loads. Live loads shall consist of uniform live loads and equipment live loads. Uniform live loads shall be assumed unit loads which are sufficient to provide for movable and transitory loads, such as the mass of people, portable equipment and tools, planking and small equipment, or parts which may be moved over or placed on floors during maintenance operations. Uniform live loads need not be applied to platform areas which will be permanently covered with equipment. A minimum uniform live load of 100 psf shall be used for walkways and platforms.

      Equipment live loads shall be calculated loads based upon the actual mass and size of the equipment and parts to be placed on floors during dismantling and maintenance, or to be temporarily placed on or moved over floors during installation.

   c. Equipment Loads. Equipment loads shall be specifically determined and located. Major equipment structural members and bases shall be designed to carry the equipment load into the structural system. The effects of impact, vibration, and torque of the equipment on the structural system shall be included in the designs of the structures.

   d. Seismic Load. Seismic loads on structures and equipment shall be calculated in accordance with Section 01612 and the California Building Code.

4. Deflection

   a. The maximum vertical deflection of the beam, grating or floor plate due to gravity loads shall not exceed 1/300 of its span.
   b. The maximum inelastic response displacement due to lateral seismic forces, Δ_M, of equipment, platforms, bins, tanks, stacks, and silos, shall not exceed 9 inches to avoid pounding with the building structure. The maximum inelastic response displacement, Δ_M, shall be equal to 0.7 times R_p times Δ_s, where Δ_s is the calculated drift of a structure subjected to the design seismic forces.

5. Foundation Anchor Bolts

   a. The Equipment Supplier shall design and furnish all anchor bolts including post installed anchors.
   b. All columns and posts shall be designed as hinged at the foundation
   c. Shear lugs will not be permitted at the underside of base plate
   d. The equipment designer shall determine the anchor embedment depth, diameter, spacing, edge distance etc. as required by ACI 318 -08, Appendix D.
   e. All post installed anchors shall be seismically qualified as per IBC / ICC.

L. Noise Limits. No process unit shall have a sound pressure reading in excess of 85 dBa within 5 feet of any direction of the unit. Enclosures or soundproofing shall be provided where required to attain the specified sound power level. Soundproofing enclosures shall have removable access panels and shall be designed for complete access to all equipment components. The entire enclosure shall be designed to be removable for maintenance purposes.

M. Safety Equipment. The System Supplier shall have the responsibility for assuring the proper safety equipment is provided and that the equipment meets all applicable safety standards. All belt or chain drives, couplings, and other moving or rotating parts shall be covered on all sides by a safety guard.

   The Seller shall be responsible for providing systems which meet all safety code requirements for their equipment and for conforming to OSHA, California Building Code with Local Amendments, and other applicable codes and regulations based upon review by the local authority having jurisdiction.

N. Spare Parts. Equipment supplied shall utilize replacement parts that are commercially available in the United States.

1.2 REFERENCE SPECIFICATIONS, CODES, AND STANDARDS

ACI – American Concrete Institute

AA – Aluminum Association

ASCE/SEI – American Society of Civil Engineers / Structural Engineers Institute

ASTM - American Society for Testing and Materials

ASME - American Society of Mechanical Engineers

BAAQMD – Bay Area Air Quality Management District

NFPA - National Fire Protection Association

FM - Factory Mutual Insurance Standards

AWS - American Welding Society

AISC - American Institute of Steel Construction

NEMA - Standards of National Electric Manufacturers Association

ISA - International Society of Automation

AGMA - American Gear Manufacturers Association

ANSI - American National Standards Institute

OSHA - Occupational Safety & Health Act

ABMA - American Bearing Manufacturers Association

UL - Underwriters' Laboratories, Inc.

NEC - National Electric Code

CEMA - Conveyor Equipment Manufacturers Association

IEEE - Institute of Electrical and Electronics Engineers

EPA - Environmental Protection Agency

1.3 CONTRACTOR SUBMITTALS

A. General: CONTRACTOR shall submit shop drawings, samples, quality control, and project record submittals of all equipment furnished under this Section and in referenced Sections.

B. Shop Drawings and Samples: Shop drawings and samples shall be submitted in accordance with the requirements of Section 01340 Shop Drawings, Product Data and Samples.

C. O & M Manuals: The CONTRACTOR shall provide operators and maintenance data for all equipment furnished for the project in accordance with Section 01730, Operation and Maintenance Data. In addition to the requirements of Section 01730, an inspection, testing and maintenance program as applicable to the drying system shall be submitted covering the requirements of NFPA 68, NFPA 69, NFPA 87, and NFPA 654.

D. Process and Instrumentation Diagrams (P&IDs)

1. P&IDs shall show a schematic representation of all equipment, piping, manual valves, control valves, connections, ductwork, motors, and instrumentation, including meters, switches, gauges, and monitors associated with the drying

system. All equipment, control valves, motors, and instrumentation shall be provided with a unique equipment tag number. Major process equipment items shall be identified on the drawings with a description, such as “dryer”. A legend shall be provided to identify all items shown on the P&IDs. Instrumentation which sends a signal to the drying system control system shall be indicated. All pipe sizes shall be indicated. Manual isolation valves shall be shown at all process equipment connections to service piping. All items which will not be provided by the System Supplier shall be clearly identified as such. The P&IDs shall follow ISA standards. The P&IDs shall cover all drying system items, including piping for process and potable water, natural gas, compressed air, nitrogen, lubrication, thermal fluid, drains, and vents associated with the drying system, located within the building and associated with auxiliary equipment. An instrumentation and control architecture drawing (block diagram) shall be included with the P&IDs.

2. Equipment, piping, valve, electrical and instrumentation equipment shall use the identification system identified on the P&IDs. Items not provided with an identification system shall be identified using the Dryer System Supplier’s standard identification system.

E. System Process Flow Diagram (PFD) with heat and mass balances at performance operating conditions.

F. Equipment plan layout drawings, showing major equipment components and ductwork, to scale including areas provided for maintenance and access. Areas required for maintenance and areas providing access to equipment, motors, control valves, and instrumentation shall be indicated on the drawings. Sufficient number of elevations shall be provided to locate all major equipment components. Layouts shall incorporate restrictions and requirements indicated herein or as shown on the Contract Drawings.

G. Air emissions data for operation of the biosolids dryer system at performance operating conditions and at maximum throughput operating conditions. Information shall include all items related to air emissions from the biosolids dryer system needed to complete the air emissions permit.

H. Structural Drawings and Calculations.

1. Structural drawings shall be to scale and shall include all relevant equipment loads, including the reactions at the base plates for deadload, live load, seismic load, and wind load (where applicable); operating, construction, testing, and environmental loads, and locations, foundations interface details, including, anchor bolt plans with bolt sizes and projections; baseplate sizes and thickness, and platform and access design, including structural column and beam sizes, platform, stair, and handrail details. The reactions for each loading condition at the base of the equipment, platforms, bins, tanks, or stacks shall be clearly indicated in the structural calculations. The Structural Drawings and Calculations shall be signed and sealed by a Civil or Structural Engineer registered in the State of California and shall conform to the requirements provided in Specification Section 01612 and 01614.

2. Appropriate detailed structural calculations shall be prepared for all structural systems. Calculations shall contain sufficient explanation and sketches to enable another civil or structural engineer to follow the work without verbal explanation. All assumptions, loadings, alternates, selections, and revisions shall be clearly

documented. Computer calculations shall include documentation clearly explaining the program function, nomenclature, and sign conventions utilized.

3. The Owner reserves the right to request a full or partial calculation submittal at any time.

I. Process Equipment Drawings. Process Equipment Drawings shall be to scale and shall show in plan and section view all equipment, piping, ductwork, and sampling locations. All equipment shall be provided with its unique equipment tag number and identified with a description. The center line of equipment and ductwork shall be dimensioned. The location of all piping connections to equipment, control valves, and instrumentation, and the sizes of the connections shall be provided for the piping systems, including plant utility water, natural gas, compressed air, nitrogen, lubrication, thermal fluid, drains, and vents associated with the dryer system. Areas required for maintenance and areas providing access to equipment, motors, control valves, and instrumentation shall be indicated on the drawings.

J. Electrical Drawings. Electrical drawings shall include the following: An electrical legend. Power distribution and control system one-line diagrams including front elevation view of all motor control center and variable frequency drive equipment. Motor starter, variable frequency drive, and control panel schematics. Interconnecting wiring diagrams. Power plans, and electrical site plan. One-line diagrams shall show all required motor control centers, variable frequency drives, disconnect switches, and all required pieces of drying system equipment. One-line diagrams shall include equipment continuous and short circuit duty ratings, provide load NEC based load calculations for motors and auxiliary equipment connected to the MCC, conduit and wire size information. Electrical schematics, including motor control schematics, shall indicate location of control elements. Interconnecting wiring and loop diagrams showing originating piece of equipment, ending piece of equipment, wire data and termination information. Power plan drawings shall show the location of all powered items, including motor control center, variable frequency drives, power panels and or lighting panels, disconnect switches, control stations, electric valves, motors, and instrumentation, including meters, switches, gauges, and monitors associated with the drying system. Each item shall be identified with its unique equipment tag number as shown on the Contract Documents. MCC drawings shall include elevations, sizing, ratings, and configuration information. The provided drawings shall clearly indicate equipment provided by the System Supplier and that equipment to be provided by the Contractor. The Electrical Drawings, which provide installation detail, including one-line diagrams, and MCC drawings, and power plan drawings shall be signed and sealed by a Professional Engineer registered in the State of California. Submittal drawings shall also conform to the requirements of Section 11000.

K. Instrument list with description, equipment tag number from the Contract Documents, measured value and calibrated ranges, high and low set points and alarms, and associated MCC, PLC, or control panel.

L. A submittal covering safety systems for explosion prevention and damage limitation for review by the code authority having jurisdiction. The submittal shall include plans, specifications, and manufacturer's recommendations for testing and maintenance, which contains information that enables the authority having jurisdiction to evaluate the explosion hazard and the effectiveness of the safety systems. Details of the plans shall include pertinent chemical and physical characteristics of the materials, location of hazards, enclosures or limits and isolation of the hazards, and exposures to hazards. The submittal shall include all design documentation applicable to the drying system

required by NFPA 68, NFPA 69, and NFPA 654. Coordinate submittal with fire alarm submittal requirements as specified in Section 16910.

M. Certification that the dryer system meets the requirements for NFPA 654, other applicable safety codes, and that it provides adequate means for preventing and controlling deflagrations and fires

N. Shipping, storage and protection, and handling instructions.

O. BAAQMD thermal fluid heater certification.

P. Installation Coordination Shop Drawings shall include the following:

1. Subassembly drawings of system components showing the extent of preassembly before shipment. Drawings must indicate approximate overall dimensions of components, and assembly requirements including and special instructions.

2. Fabrication details for any field fabricated items. Field fabrication shall be minimized.

3. Detailed description of any special handling requirements.

Q. Instrumentation Controls shop drawings shall include the requirements of 11000 and the following:

1. Field instruments:

a. Catalog cuts.
b. Data sheet.

2. Point-to-point wiring diagrams.

3. Control loop diagrams.

4. Control panels and stations:

a. Front, rear and side views showing access and conduit entry points.
b. Assembly drawings.
c. Front elevation showing: panel instrument layout, legends, and nameplates.
d. Interior panel elevations showing location of all back of panel mounted instruments, power supplies, fuses, relays, PC's and terminal blocks, legends, and nameplates.
e. Electrical schematics, point to point, internal panel wiring and terminal block arrangement for external connection.

5. Field and Panel Instrument shop drawings shall include the following:

a. ISA S20 Data Sheets with the following information as a minimum:

1) Tag number per the Specifications and Contract Drawings.
2) Product (item) name used herein and on the Contract Drawings.
3) Name of the Manufacturer or supplier.
4) Manufacturer's complete model number.
5) Location of the device.

6) Input-output characteristics.
7) Range size and graduations.
8) Physical size with dimensions, NEMA enclosure classification and mounting details.
9) Materials of construction for all components.
10) Instrument or control device sizing calculations, where applicable.
11) Certified calibration data on all flow metering devices, where applicable.
12) Environmental requirements during storage and operation.

6. Programmable Logic Controller and Human Machine Interface Shop Drawings:

a. Submit in accordance with Section 11000.
b. Programmable logic controller hardware shop drawings including:

1) System architecture and interconnection diagram showing all device network connections and point of connection to the Plant SCADA system.
2) Indicate IP addresses for all Dryer network resident equipment. Coordinate IP addresses with the requirements of Section 13422.
3) PLC component bill of material detailing all PLC controller and networking equipment provided
4) PLC I/O list showing tag, type, function, rack, slot, and point definition

c. Programmable Logic Controller Shop Drawings: Programmable logic controller shop drawings (ladder diagrams, etc.) shall be submitted for information including a printout of the program as well as a software copy in the native PLC programming software language. Ladder diagrams shall include comments in the listings to describe program steps. The following documents shall be submitted as a minimum:

1) Cross reference table: This table will list all registers and coils description with reference to the rung numbers.
2) PLC configuration data including input/out assignment, PLC memory organization and communication baud rate, if applicable.
3) PLC Manufacturer's application programming manual.
4) All ladder diagrams, function block diagrams, structured text, instruction list, and sequential function charts, including program comments.
5) Communication details for sending and receiving data from Plant SCADA system as required per Section 13421
6) Specific definition of all plant based interlocks and permissives required by the Dryer system for operation as specified.

d. Human Machine Interface (HMI) Shop Drawings

1) HMI Hardware shop drawings including catalog cut sheets and installation details
2) HMI graphics screens indicating conformance to the City's existing SCADA system "look and feel" as specified in Section 13400.

R. Electrical Equipment Shop Drawings shall include the following:

1. Submit Variable Frequency Drive catalog and technical data in in accordance with Section 16260.

2. Submit motor control center catalog and technical data in in accordance with Section 16442.

3. Catalog cuts for all other ancillary electrical equipment.

4. Manufacturer's standard shop drawing information for panel boards, disconnect switches, transformers, TVSS, low voltage power factor correction capacitors, MCC's and VFD's.

S. Structural Shop Drawings shall include the following:

1. Size and location of all structural members and connection material.

2. Complete information necessary for the fabrication of members including cuts, copes, holes, doubler plates, stiffeners, and camber,

3. Type, size and location of bolts and welds,

4. Surface preparation and finishes,

5. Details of assembly,

6. Identification of shop-installed high-strength bolted connections as snug-tight, pretensioned or slip-critical, as required by the design, and

7. Identification of Weld Procedure Specification (WPS) applicable to each shop weld. Welded connections shall be identified using standard AWS symbols as given in AWS A2.4, Standard Symbols for Welding, Brazing and Nondestructive Testing, and shall clearly distinguish between shop and field welds.

8. Structural Erection Drawings shall include the following:

a. Location of all structural material,
b. Identification mark of members,
c. Orientation and relation of members to appropriate grid lines,
d. Setting elevations for column bases,
e. Standard and special details for bolted and welded field connections,
f. Identification of field-installed high-strength bolted connections as snug-tight, pretensioned or slip-critical, as required by the design calculations, and
g. Identification of Weld Procedure Specification (WPS) applicable to each field weld. Welded connections shall be identified using standard AWS symbols as given in AWS A2.4, Standard Symbols for Welding, Brazing and Nondestructive Testing, and shall clearly identify field welds.

9. Anchor bolt details, including the type, size, and location.

1.4 QUALITY ASSURANCE

A. CONTRACTOR shall submit the following:

1. MANUFACTURER's Certificate of Proper Installation

2. Functional Test Certification

3. Factory performance test reports

4. Special shipping, storage and protection, and handling instructions

5. MANUFACTURER's printed installation instructions

6. List of suggested spare parts to maintain the equipment in service for a period of 5 years. Include a list of special tools required for checking, testing, parts replacement, and maintenance.

7. List of special tools, materials, and supplies furnished with equipment for use prior to and during startup.

B. Warranty

1. A written suppliers warranty shall be provided for the equipment specified in this section as required in Section, 01740 Warranties and Bonds.

1.5 MANUFACTURERS SERVICE REPRESENTATIVE

A. Manufacturer's Representative. Provide in accordance with the requirements of Section 01660 Testing and Training and Section 11000 Equipment General Provisions.

B. A Manufacturer's Representative shall be present at the site or classroom designated by the OWNER to provide the services and minimum person-days listed below, travel time excluded. Additional days required beyond the days listed below shall be provided at no additional cost to the Owner, unless the Owner requests additional training or support.

1. 20 person-days for installation assistance and inspection,

2. 15 person-days for functional, operational and performance testing

3. 5 person-days for training of OWNER's personnel.

PART 2 PRODUCTS

2.1 GENERAL

A. The biosolids dryer system shall be complete with all required and necessary equipment, access requirements and provisions, motors, drives, safety guards, controls and instrumentation, control panels, sensors, sound proofing, and equipment thermal insulation as specified herein, required for a complete and operable system as specified herein. Materials and details of constructions shall be System Supplier's standard for service conditions and performance requirements specified unless noted otherwise in this specification.

B. The System Supplier shall provide the Contractor the type, size, and location of anchor bolts required for the drying equipment. Refer to structural drawings and specifications for new and existing concrete design criteria.

C. Permanent sampling ports shall be provided as required for sampling of solid and air streams within process units. The sampling ports shall be arranged in a manner that allows safe sample collection and minimized material leakage or spillage during sampling.

D. Deflagration and Fire Prevention and Protection

1. The sludge dryer system shall meet the requirements of the latest edition of *NFPA 654, Standard for the Prevention of Fire and Dust Explosions from the Manufacturing, Processing, and Handling of Combustible Particulate Solids*. The drying system shall be designed by and installed under the supervision of qualified engineers who are knowledgeable of this system and its associated hazards. The System Supplier shall be responsible for providing systems which meet all safety code requirements, including NFPA 654, including any items required based upon review by the local Authority Having Jurisdiction. Fire detection systems, including electrical circuits, shall be designed in accordance with NFPA 72.

2. In addition to the requirements of NFPA Standard 654, and other applicable safety codes, the System Supplier shall provide adequate means for preventing and controlling deflagrations and fires for the processes included with their dryer system and the requirements specified herein.

3. An exterior deflagration deflector duct, if deflagration venting is provided per the Dryer System Supplier's design, shall be provided exterior of the building and shall direct material and gas ejected upward. The Dryer System Supplier shall be responsible for the design of the exterior deflector duct, the connection of the exterior deflector duct to the deflagration duct inside the building and/or the exterior of the building; and the exterior deflector duct vertical supports and connections. The design shall be coordinated with the Metal Building designer, designed per the Structural Design section of this specification and shall be designed to accommodate the thermal expansion of the deflagration system. The deflector plate shall be provided with drain ports to prevent accumulation of moisture in the deflector plate.

4. Combustible dust characteristics will vary based on the character of solids received by the wastewater treatment plant for treatment and the treatment processes used. Safety system design should account for all combustible dust characteristic variations which may occur. In no case shall less stringent design values be used than those listed below:

   a. Limiting Oxygen Concentration, percent: 10
   b. Dust Explosion Constant, Kst, bar-m/s: 150
   c. Maximum Explosion Pressure, Pmax, bar: 8
   d. Minimum Explosive Concentration, gram/cubic meter: 50

5. Equipment protected with inertization, if inertization is used by a System Supplier as a basis for providing protection, shall be protected from explosion during operation of the plant as a result of an inert atmosphere (8 percent oxygen or less) in accordance with NFPA 69. The inert atmosphere shall be confirmed before material is introduced into the dryer. Oxygen concentration shall be monitored in accordance with ISA S84.01.

6. The System Supplier shall perform a Dust Hazards Analysis (DHA) covering the dryer system as specified herein. The purpose of the DHA study shall be to examine the design in a systematic and structured manner in order to identify significant hazards (health, safety or environmental), including fire and explosion hazards, and associated major operability problems. Having identified these, recommendations shall be made to resolve or mitigate the hazards and, in so doing, increase the level of safe operation of the facility under review. The System Supplier shall lead the DHA (a minimum of two days), provide a DHA report, and implement the DHA recommendations. The System Supplier shall provide the services of a firm specializing in the facilitation of DHAs, which shall provide a facilitator, scribe, computer and hardware and software for recording study proceedings, and produce the DHA report. The DHA report shall be submitted in accordance with Section 01340. An electronic copy of the report, which can be edited, shall be submitted to facilitate report updates. The Owner will participate in the DHA. The DHA shall be conducted at the Owner's facilities. The DHA study shall be in accordance with the requirements of NFPA 654 for the dryer system.

E. Unless required by code or specified otherwise in the body of the specifications, all welds shall be of proper size and properly prepared and shall be free of undercuts and inclusions and shall have weld spatter and scale removed. Burn marks and soot shall be removed from welds. Carbon steel and stainless steel piping shall be welded in accordance with the latest edition of ANSI B31.3 Code for Pressure Piping. Equipment shall be welded in accordance with the latest editions of ANSI/AWS D1.1 for carbon steel equipment, and ANSI/AWS D1.6 for stainless steel equipment, except where specified to meet the ASME Boiler and Pressure Vessel code. Ductwork shall be welded in accordance with the latest edition of AWS D9.1. At a minimum, all welds shall be visually inspected, in accordance with the referenced standards, in addition to any additional inspection requirements of those standards. E309 electrodes shall be used when welding either Type 304, 304L, 316, or 316L to carbon steel.

F. Tools: Special tools necessary for maintenance and repair of the equipment shall be furnished as a part of the work; such tools shall be suitably stored in metal tool boxes, and identified with the equipment number by means of stainless steel or solid plastic name tags attached to the box.

G. Service Conditions

1. The dryer system shall be designed for the following service conditions.

2. The dryer system will be used to dry dewatered waste activated biosolids. Dewatered biosolids will be conveyed from existing belt filter presses by a series of conveyors to the dryer feed hopper. In the future, dewatered solids may be provided by centrifuges. Biosolids will be fed from the dewatered sludge hopper to the biosolids dryer, processed in the dryer and discharged by a conveyor to a cooler before being screened. Over and under sized dried solid product (Off-spec) material will be returned to the dryer inlet. Product will be further cooled and transported to a discharge loadout conveyor. All dryer system equipment, except for equipment to be installed in a control or electrical room, shall be suitable for installation in a wet, abrasive, and corrosive environment. The dryer system equipment will be installed in the Dryer Building except as shown on the drawings.

3. Equipment shall be suitable for the following design conditions:

Equipment located in Dryer Building:	
Ambient temperature, F	105
Equipment located outside	
Ambient temperatures, F	102
Design wind speed, mph	Refer to Spec 01614
Wind exposure category	Refer to Spec 01614
Seismic Design	Refer to Spec 01612
Plant elevation, ft. above MSL	Refer to Drawings
Maximum height of any drying equipment located within the drying building, above the operating floor, ft.	21-ft. All equipment must accommodate the Dryer Building bridge crane and to allow for the crane to convey picked equipment over installed equipment.

4. Fuel supply for the dryer system will be natural gas with a heating value, of 1,000 Btu per standard cubic foot and available supply pressure will be 2 psig at thermal fluid heater equipment fuel inlet valve.

5. Equipment using plant utility water should be designed for a maximum water temperature of 81 degree Fahrenheit. Plant utility water supplies have an average Total Suspended Solids (TSS) of 1.9 milligrams per liter and an average hardness of 278 mg/L as $CaCO_3$. Plant utility water pH ranges from 7.0 to 8.5 Plant utility water is plant effluent treated to meet Title 22 compliance. Plant utility water supply includes the following:

Available Supply	450 gpm
Available Pressure at Available Supply	80 psi

H. Performance Requirements

1. The dryer equipment shall be designed to operate satisfactorily under the following conditions and performance requirements. The drying system, including all its components, shall be designed to operate satisfactorily throughout the range of specified conditions. The drying system shall be designed to process solids continuously.

Requirements	**Normal Operation**	**Performance Requirements**
Number of Drying Units	1	1
Type of sludge feed material to dryer from belt filter presses Future sludge feed material to dryer will be	Dewatered waste activated sludge	Dewatered waste activated sludge

Requirements	Normal Operation	Performance Requirements
from centrifuges		
Operation, Days per week Hours per week	 5 100	 - -
Evaporation rate , lbs. of water per hr	-	4,536 (based on 100 hr per 5 day work week)
Dewatered sludge feed to dryer, % dry solids	14 to 20	15, or as established during testing
Solids rate, each unit, dry lbs. per hour at 20 % dry solids	1,159	As required based on the evaporation rate and the dewatered sludge feed % dry solids as established during testing
Dried product solids, % dry solids	92 to 95	92 minimum
Dried product temperature, downstream of product cooler, max, °F	≤ 120	≤ 120
Maximum surface temperature of sludge drying equipment with a 105°F ambient temperature, °F	140	140
Maximum fuel usage, BTU/lb of evaporated water	NA	1,450
Maximum electricity usage, kW	NA	175
Dried product		Meet Class A dried product per US CFR 40 Part 503
Size: Percent by weight between 1 to 8 mm		90 minimum
Minimum product bulk density, lbs/ cu ft		35

2. Air emissions from the dryer system shall comply with all applicable Federal, Bay Area Air Quality Management District (BAAQMD) requirements and requirements of the wastewater treatment plant's air emissions permit, as amended for the dryer system.

3. The dryer system shall require no more than 120 minutes to complete startup, when dewatered sludge can be introduced into the system, including all safety

checks. The drying system shall require no more than 240 minutes to complete a normal shutdown, when all process equipment can be turned off.

I. Motors

1. Provide in conformance with applicable requirements of Section 16220.

2. Where motors are operated under variable frequency drives provide inverter duty rated motors per NEMA MG-1.

3. Provide motor winding temperature switches where specifically specified herein and for all motors operated under variable frequency drives.

4. Provide integral motor winding space heaters for all motors provided under this Section.

J. Controls

1. The drying system shall be provided with a complete control package, including all control panels, PLC system, I/O, programming and software, including PLC logic, HMI pictorial graphic displays, alarm monitoring and logging, operator interface devices, field instruments, both electronic and mechanical, operator terminals, communication devices, and data exchange with the existing City Plant Control system as required for a complete and operable system as specified herein. Provide control system and components in accordance with Section 11000.

2. Provide control components and equipment to match existing City standard equipment per Section 11000 and as shown on the Drawings. Matching equipment shall include but not be limited to:

   a. PLC hardware: Modicon/Schneider Electric M340 family with associated power supplies, I/O cards, and ancillary devices
   b. PLC Software: Programming using Schneider Electric Unity Pro software using ladder logic code
   c. Network hardware and architecture based on Modbus TCP protocol
   d. Other equipment as specified in Section 11000.

3. HMI screens created for this Project shall match the look and feel of the graphic screens presently in use at the overall plant control system. In particular, color requirements, control sequences, screen navigation and layouts shall match City's existing system as specified under Section 11000 and as provided to the System Supplier after Notice to Proceed. Supplier standard graphic screens shall not be acceptable. Provide a minimum of 25 custom HMI control graphic screens for the Dryer system. Standard alarm summary screens and system popups screens shall not count against the specified 25 process control graphic screens required:

   1) Overall System Navigation Screen (physical or hierarchical tree representation)

   2) Tabular Screen Index

   3) Dryer PLC and Control Network Diagnostics Screens

4) Dryer, components, conveyors, compressor and ancillary systems

5) System multi-pen trend screens

4. The control system shall be designed to minimize operator requirements and movement in control of the sludge drying and storage equipment. A control system is required from which the entire system can be started, stopped and operated under normal conditions. The heat drying control system shall interface with the overall Plant Control System (PCS) to allow operators to monitor system performance of the heat drying system from the overall PCS.

5. The control system shall be a PLC based system utilizing a PC-based Human Machine Interface for input to system operation and shall be provided as specified in Section 11000.

6. The SCADA Network Block Diagram drawings (included as Drawings I02 and I03 of the Contract Documents) depict the integration of the heat drying system to the existing treatment plant. The control system shall be capable of full two-way communications with the overall PCS under a Modbus TCP protocol. Communications shall include the capability to transmit all plant status and alarms and PLC status as well as receive any required setpoints or system initiations from the overall PCS. All system statuses and alarms shall be made available to the overall PCS, including subsystems such as the heat dryer system, wet material bins, product storage silos, and cake loadout silos. All statuses and alarms transmitted to the overall PCS shall be stored in contiguous registers.

7. The necessary hardware and software required to implement the communications described herein shall be included with the Dryer System Supplier's scope of control systems work.

8. Provide PLC, HMI, control panel fabrication and ancillary control hardware and software as specified under Section 11000.

K. Protective Coating

1. Materials and equipment shall be coated in accordance with Section 09900 Painting and Coatings and the Contract Documents.

L. System Suppliers

1. System Supplier's Experience: The materials and equipment covered by this specification are intended to be standard materials and equipment of demonstrated successful performance and supplied by a manufacturer who has been actively engaged in the supply of similarly sized paddle drying systems for a minimum of 5 years and has supplied indirect dryer systems in North America that have been in service for more than 5 years. Equipment shall be designed and constructed in accordance with the highest standards of the industry and shall be installed in accordance with the System Supplier's recommendations and the Contract Documents.

M. Unit Responsibility:

1. The Supplier shall submit letters of certification with the shop drawings from the VFD manufacturer, the motor manufacturer, and the driven equipment manufacturer

stating that they have reviewed each application and that the combination will satisfy the application duties required, for the actual motor sizes required, regardless of deviations from the scheduled "nominal horsepower."

2. Where a package process system supplier is responsible for supplying the pump, motor and VFD as required herein, the supplier shall coordinate the VFD and motor and provide certification that the driven equipment, motor, and VFD are compatible and will meet the system requirements of the application. Certification from the supplier shall state that they have reviewed application requirements and that the equipment, motor, and VFD combination will satisfy the application duties required, incorporating any deviations from the nominal horsepowers shown on the Contract Documents.

N. System Suppliers:

1. Komline-Sanderson.

2. Andritz Separation, Inc.

3. Or Approved Equal.

2.2 DEWATERED SLUDGE HOPPER

A. General – <52-ME-10-DWS> The dryer system shall be provided with a live bottom dewatered sludge hopper. The live bottom shall include two shaftless VFD driven screw conveyors (52-ME-11-DWS, 52-ME-12-DWS) to deliver dewatered sludge from the hopper to the dewatered sludge pumps.

B. Performance requirements

1. Minimum operating storage capacity of 20 cubic yards of dewatered sludge.

2. The hopper walls shall be adequately sloped to ensure that all material will move through the hopper. Design, including minimum deflection requirements, and construction shall comply with the latest editions of AISC and AWS. The roof shall be designed as a working platform for dead load plus live load of 100 pounds per square foot minimum and to support Dewatered Sludge Conveyor 4. The hopper vessel and supports shall be designed to support the loads from the end support of the screw conveyor that will be transferred to the hopper. The System Supplier shall coordinate with the conveyer manufacturer for the loads.

3. The hopper shall be provided with a ladder for access to the top of the hopper and guardrails around the perimeter of the top of the hopper.

4. The dewatered sludge hopper shall include two access doors, each with a minimum 24 inch by 24 inch opening, one located on the top of the hopper and one located along the bottom 1/3 of the hopper. The top access door shall be gasketed and hinged with a locking clasp. The access door along the bottom shall be bolted and gasketed.

5. Each dewatered sludge hopper shall be provided with a live bottom utilizing two shaftless screw conveyors to feed either of the two the dewatered sludge pumps. Each screw conveyor shall have a 2 inch drain.

6. The dewatered sludge hopper shall be provided with two progressing cavity dewatered sludge pumps as specified in Section 2.3 Dewatered Sludge Pumps. The dewatered sludge hopper shall be designed to ensure that dewatered sludge will flow into either of the suction of the dewatered sludge pumps without bridging.

7. The dewatered sludge hopper shall be provided with an 8” flanged inlet air vent with stainless steel bug screen and ring flange and an 8-inch flanged air outlet vent for discharge to the existing fan suction as shown on the Drawings.

8. The dewatered sludge hopper shall be provided with one 18-inch x 18-inch flanged opening on top which shall be coordinated with the screw conveyor discharge chute. The hopper top shall be designed and provided with a conveyor support in the general location shown on the Drawings and designed to resist all applicable loads (i.e. dead load, seismic, etc.). The height of the conveyor is shown on the Drawings and the tributary load to the support is estimated to be 2300 lbs. The conveyor support shall be coordinated with the conveyor being supplied as specified in Section 14552.

9. Shaftless screw conveyors shall consist of spiral flighting only attached to a flanged connecting plate. Spiral flighting for the shaftless screw conveyors shall be designed to convey material without a center shaft or hanger bearings.

10. Each shaftless screw conveyor shall be provided with inner and outer spirals to increase axial strength and capacity. Conveyors shall have an inner flight thickness shall not be less than 3/4 inch and outer flight thickness shall not be less than one inch. Minimum cross sectional area for conveyors having a diameter smaller than 15 inches shall be 2.9 square inches and conveyors having a diameter of 15 inches and larger shall be 4.3 square inches. The spiral flights shall be designed for the maximum torque requirements of the equipment specified. The "spring effect" of the spiral shall not exceed 30 mils per foot of length assuming the conveyor and hopper is completely full (100% fill factor) of the material specified herein. Flights shall be formed from cold spring steel having a minimum 72,000 psi tensile strength and a minimum 220 Brinell hardness.

11. Spiral flighting shall have full penetration welds at all splice connections. The flights shall be aligned to assure true alignment when assembled and shall be made according to the manufacturer's recommendations. The connection of the spiral to the drive system shall be through a flanged connection plate that is welded to the spiral and shall form a smooth and continuous transformation from the flange plate to the spiral. The drive shaft shall have a mating matching flange and shall be bolted to the spiral connection plate.

12. Each shaftless screw conveyor shall be driven by an electric motor through a direct drive gear reducer. Drive units shall be designed for 24 hour continuous service.

13. Gear reducers shall be a totally enclosed unit with oil or grease lubricated, rolling element, antifriction bearings throughout. Gear reducers shall be AGMA Class II, single or double reduction, helical gear units with high capacity roller bearings. Bearings shall be designed for the maximum thrust during startup of a conveyor and hopper completely full (100 percent fill factor) of dewatered cake, and shall have a minimum ABMA L10 Life Rating of 100,000 hours. The reducers shall be standard air-cooled units with no auxiliary cooling allowed. The gear housing

shall be of 30,000 psi cast iron, with removable inspection cover(s), oil breather(s), oil level indication, fill and drain holes with plugs; gearing lubricated through an oil bath for the mounting position and inclination required. The gear reducer shall be sized with a torque service factor of 1.5 based on motor nameplate, at the driven (output) shaft speed, whichever is greater. Gear motors in which the motor is integral with the gear reducer is not acceptable.

14. Flanged drip-less slide gates shall be provided for each screw conveyor discharge opening. Gate surfaces in contact with the conveyed material shall be constructed of minimum 1/4 inch thick Type 304L stainless steel. All other surfaces shall be constructed of 1/4 inch thick, steel or Type 304L stainless steel materials. All welding shall be per AWS standards. The gate blade shall be constructed of Type 304L stainless steel. The gate blade shall be supported on 1 1/4 inch stainless steel rollers, which are located out of the material flow. The rollers will include bronze bushings, which require no lubrication. The gate blade leading edge shall be beveled to facilitate its travel through the material being handled. The gate shall be provided with a ramping mechanism to help force the gate blade against the seal. The retract frame shall incorporate expanded metal guards for safety purposes.

15. Gate wiping seals shall be made of UHMW polyethylene. The seals shall contact the top of the gate blade along the perimeter of the throat opening. The seals shall be retained by a bolted steel bar which forms the inlet throat lining of the slide gate.

16. The slide gates shall have single acting-spring return air cylinder actuators with exhaust mufflers and speed control valves. Cylinder type actuators shall be provided by the gate manufacturer. Cylinder type actuators shall provide satisfactory operation with dry, oil free instrument air at minimum 80 psig pressure (or greater as coordinated by System Supplier with their compressed air system) and shall be shop tested at 240 psig.

17. Cylinder type actuators shall consist of a heavy-duty, front head-mounted single acting-spring return pneumatic cylinder, constructed to ANSI specified dimensions for interchangeability. Each cylinder shall include hard, chrome-plated rod; long-wearing, double seal configuration; and a heavy steel cylinder tube. Each cylinder shall be clevis mounted to the slide gate blade.

18. The gate actuator mechanism coupled to the cylinder shall be totally enclosed. The cylinder shall be rigidly secured to the mechanism housing and shall not pivot, rotate, or swing during operation. The cylinder piston rod shall be enclosed in the mechanism housing and shall not be exposed to view. The cylinder type actuator shall be configured such that on power failure, the spring shall drive the gate open or closed as determined by the Dryer System Supplier based on the functional requirements of the system. Each actuator shall be furnished with a 3 way solenoid valve. A flow control valve shall be furnished and installed in the solenoid valve vent.

19. Air piping, isolation, and two-way diversion solenoid valves shall be pre-mounted on the gate. Valves shall be provided in air lines to allow for speed adjustment for opening the slide gate and shall be supplied by the System Supplier's compressed air system. Solenoid valves shall be single coil rated 120 volt ac and shall be energized to open or close the slide gate valve as determined by the Dryer System Supplier based on the functional requirements of the system.

20. Each gate shall include one pair of limit switches, spdt, 316 stainless steel NEMA Type 4X enclosure suitable for use in a NEC Class II, Division 2, Group G area, mounted to the gate retract frame to provide remote Open/Close position indication. The Dryer System Supplier shall provide all supports for the actuator. Supports shall resist all loads imposed by the actuator, including thrust during operation.

21. Two (2) flanged ports on the roof of the hopper for connection of the pressure relieving rupture disc vent piping.

C. Materials of construction

1. Hopper housing including structural reinforcement elements: welded Type 304L stainless steel plate with a minimum thickness of 3/16 inches.

2. Ladder: Type 304L

3. Access doors: constructed of Type 304L stainless steel plate with a minimum thickness of 3/16 inch

4. Slide gate housing and blade: Type 304L

D. Controls

1. Controls shall be supplied in accordance with Section 11000 and as specified herein.

2. Each dewatered sludge hopper shall be provided with the following instrumentation to send signals back to the dryer control system for monitoring and system control:

   a. Two radar level transmitters, stationed near the one-third and two thirds points along the long axis of the dewatered sludge hopper. The control system shall display individual level and averaged level. Each level transmitters shall be mounted on a 6-inch flanged nozzle. Provide per Section 13433.
   b. High level switch, low level switch, and high-high level switch per Section 13433.
   c. Motor operating status.
   d. Motor high temperature switch (integral with motor)
   e. Zero speed switch.
   f. Speed indication for screw conveyors.

E. Motor:

1. A variable speed motor shall be provided to drive each live bottom screw conveyor. Provide inverter duty rated motor in accordance with NEMA MG-1.

2. Motor: Shall be in accordance with Section 16220 Low Voltage Motors and as specified herein. Motors shall be listed for installation in a NEC Class II, Division 2, Group G area and a NEC T Code of T3.

F. Spare parts: One of each type and size of screw conveyor bearings.

2.3 DEWATERED SLUDGE PUMPS

A. General – <52-P-01-DWS, 52-P-02-DWS> The dewatered sludge hopper shall be provided with two (2) progressing cavity pumps to convey dewatered sludge to the biosolids dryer.

B. Performance requirements

1. Each variable speed sludge dewatered sludge pumping unit shall be provided complete with feed hopper, an electric motor and an variable speed drive and shall be designed to continuously pump dewatered sludge with 15 to 20 percent solids content.

2. The System Supplier shall verify the pressure and capacity of the pump. Each pump shall have a maximum pressure per pump stage of 50 psi, and the motor shall be sized for the system losses plus an additional 25 psi pressure differential. The pump shall have a minimum pressure differential rating of 100 psi (and have a minimum of 4 stages) or greater if required by the operating conditions and piping configuration, and a maximum pump speed of 75 rpm at the design normal operation.

3. Each pump discharge shall be supplied with a 2” pipe routed to the top of the Dewatered Sludge Hopper. Each 2” pipe shall be supplied with a rupture disc. The rupture disc shall be located in a section of pipe removable with a victaulic coupling and shall have a sensor to indicate when the disc has ruptured. A spare rupture disc with pipe section shall be supplied that is the same length as the installed section. Dryer System Supplier shall size the rupture disc and shall coordinate the size and set points with the sludge pumping system design. The rupture disc shall be as manufactured by Zook Enterprises or equal.

4. Dewatered sludge pumps shall be furnished by or through a single supplier or manufacturer who shall coordinate the items of equipment, connections, compatibility of the feed systems, discharge dewatered sludge pipe size, and controls to ensure the compatibility and proper operation of all items of equipment. The dewatered sludge pump supplier shall be responsible for determining design pressure differential rating based on the operating conditions and piping configuration for sizing and selecting the dewatered sludge pumps. Although the design drawings depict 8” diameter dewatered sludge piping between the hopper and dryer a minimum of 6” diameter piping will be acceptable based on the Dryer System Supplier’s sludge pumping system design.

5. Inlet connections to the dewatered sludge pump shall be through a rectangular opening. The dimensions of the opening shall be no less than the following: Width and Length – equal to or greater than the width of the discharge from the Dewatered Sludge Hopper live bottom screw conveyors.

6. A single helix ribbon auger shall run the entire length of the suction casing and the extension tube and shall transmit rotational movement from the drive shaft to the rotor. The feed auger shall operate within a defined removable compression zone. The auger shall have a shoulder disk to close the remaining gap between the plug-in orifice and coupling rod resulting from eccentric motion. The auger shall be designed to convey no less than 300 percent of the rated capacity of the pump at all points within the specified operating range.

7. A cleanout opening with bolted removable cover and a tapped and plugged drain connection shall be provided in the suction housing.

8. An access opening shall be provided for stuffing box maintenance. A pocket with tapped drain connection shall be provided for collecting and draining the stuffing box leakage to the nearest bell-up or floor drain.

9. Suitable fittings shall be provided for properly adding bearing lubricant. The bearing housing shall be adequately sealed to prevent contamination of the bearings and to retain lubricant.

10. Each drive shaft shall be of solid or hollow design and shall be fully machined or ground to size and polished. Portions of the shaft passing through the stuffing box shall be hard chrome plated or shall be provided with a replaceable hardened or chrome plated shaft sleeve. The drive shaft shall be of ample size to transmit the maximum applied power at the maximum specified differential pressure and to carry all applied radial loads without excessive deflection.

11. Each connecting rod assembly shall consist of a solid connecting rod with a positively sealed and grease lubricated universal joint at each end. The assembly shall be of sufficient size to transmit the maximum applied power at maximum rated differential pressure. The joint shall be lubricated with a high temperature (450 degree Fahrenheit rated) lubricant, closed or covered with Buna N bellows or sleeve and positively sealed with compressive mechanisms constructed of corrosion resistant metals.

12. A Type 316 stainless steel shell shall cover the universal joint assembly to protect the elastomer sleeve or bellows from being damaged by tramp metals or glass. Universal joints shall be positively sealed and lubricated to withstand a minimum of 45 psig of pressure. The universal joints shall carry a separate warranty of 10,000 operating hours. This warranty shall be unconditional in regards to damage and wear.

13. Pin joints shall have replaceable, hardened steel bushings in the coupling rod, rotor and drive shaft heads and pins shall be constructed of hardened high-speed drill steel. Pin joints shall have not more than 3 degrees of angularity. Gear joints shall have replaceable ball and ring gears and keys constructed of hardened tool steel. Thrust plates in gear joints may be constructed of cast iron or bronze. Gear joints shall not have more than 1.5 degrees of angularity.

14. At least two anti-friction bearings shall be provided. The inboard bearing shall carry radial loads, and the outboard bearing shall carry both radial and thrust loads. Each bearing shall have an AFBMA L10 Life Rating of 100,000 hours at the maximum differential pressure. Shaft speed shall not exceed the limits specified by the bearing manufacturer.

15. Each dewatered sludge pump shall consist of a convoluted rotor and operating in a similarly convoluted stator. The convolutions shall be configured to form a cavity between the rotor and stator, which shall progress from the pump's inlet to discharge with the operation of the rotor. The fit between the rotor and stator at the point of contact shall compress the stator material sufficiently to form a seal and to prevent leakage from the discharge back to the inlet end of the pumping chamber.

16. The ability to clean the dewatered sludge pipeline shall be added by placing a 4-inch wye connection with blind flange on the pipeline near the dewatered sludge pump discharge at the dryer. The wye shall connect via flange to a ball valve which is in turn connected by flange to a quick connect and flange shall be Class 300 to match the flange pattern of the ball valve.

C. Materials of construction

1. Body and supports: Cast iron, ASTM A48.

2. Rotor: Type 316 stainless steel, with a minimum 0.010" Duktil coating, Vickers 1350+.

3. Stator: Therban (Hydrogenated Buna-HNBR) synthetic rubber, Shore A Durometer 60, enclosed in a steel pipe sleeve.

4. Augur: Type 420 or 316 stainless steel.

5. Connecting rod: Shaft grade Chrome-Molysteel or 400 series steel.

6. Pin joint bushings: Air hardened tool steel, Rockwell 57-60.

7. Bearings: Antifriction, oil lubricated.

8. Mechanical seal: Durametallic "Double Duraseal" or John Crane "Type 1 Multiple ShaftSeal".

D. Controls

1. Controls shall be supplied in accordance with Section 11000 and as specified herein.

2. Dewatered sludge pump controls shall be provided with the following instrumentation to send signals back to the dryer control system for monitoring and system control:

   a. An indicating pressure transmitter and high pressure switch located at the discharge of the pump, which shall indicate pump discharge pressure and shut down the pump on excessive pressure. Provide per Section 13434.
   b. Pressure transmitters shall be provided with an in-line, flow-through, flange type gauge isolator, with flexible liner.
   c. Thermistor located in the stator, which shall shut down the pump when high temperature indicates a run-dry condition.
   d. Operating status.
   e. Pump speed.
   f. Power use.
   g. Motor high temperature switch (integral with motor).
   h. Alarm conditions
   i. Pressure relieving rupture disc open signal

3. In addition, a temperature gauge shall be provided on each pump discharge.

E. Motor

1. The motors shall specifically be selected for service with an adjustable frequency type speed controller and shall be derated as required to compensate for harmonic heating effects and reduced self-cooling capability at low speed operation.

2. The pumps shall be furnished with a variable frequency drive coordinated with the requirements of the pumping unit, with particular attention directed toward the torque requirements.

3. Motor: Shall be in accordance with Section 16220 Low Voltage Motors and as specified herein. Motors shall be listed for installation in a NEC Class II, Division 2, Group G area and a NEC T Code of T3.. Where operated from a variable frequency drive the motor shall be inverter duty rated per NEMA MG-1.

F. Spare parts

1. Two sets of bearings

2. Three rotors

3. Two stators

4. Connecting rod assembly complete with universal joints and seals, one set

5. One additional rupture disc as specified herein.

G. Pump Manufacturers or Approved Equal

1. Seepex

2. Moyno

2.4 PADDLE DRYER

A. General – <52-ME-10-DRS> One (1) indirect heated paddle dryer shall be furnished, including discharge weir gate (52-G-11-DRS), dryer drive (52-ME-11-DRS), reducer cooling fan (52-F-11-DRS), and discharge rotary valve (52-V-11-DRS).

B. Performance requirements

1. Refer to Paragraph 2.16 for rotary valve requirements.

2. The dryer shall consist of a base mounted, jacketed trough and cover containing two agitator assemblies comprised of hollow agitator shafts with multiple hollow paddles, for use as heat transfer surfaces in conjunction with the heat transfer surface of the jacket.

3. The dryer shall include a double omega shaped trough and vaulted bolted cover for all process contacted parts and steam jacket.

4. Trough shall be designed and tested in accordance with ASME Code Section VIII, Division I, with design temperature and pressure of 550 degrees F at 125 psig.

5. Provide explosion panels for controlling deflagrations, with either a discharge vent to the building exterior of with particle retention and flame arrestance devices. If a discharge vent to the building exterior is provided, design trough and cover on process side for a minimum vent pressure of 1.5 psig with cover to include explosion panels to vent dryer gasses above 1.0 but less than 1.5 psig. Design explosion panels and deflagration duct inside the building, and exterior deflection duct in accordance with NFPA 68 standards. If particle retention and flame arrestance devices are provided, design trough and cover pressure capability, explosion panels, particle retention and flame arrestance devices in accordance with NFPA 68 standards.

6. Trough bottom and sides from the bottom to the centerline of the shafts shall be provided with hard surfacing. Hard surfacing shall consist of 0.125 inches thick weld applied chromium carbide alloy with a minimum HRC hardness of 56, or Hardox wear sheets, or Owner approved equal.

7. Vaulted cover shall provide sufficient space to allow for the removal of vapors generated during the drying process, with vapor velocities not to exceed 5 feet per second to minimize dust entrainment. Vaulted cover shall have two (2) 8 inch round flanged inlet in cover at the drive end for feed sludge; one (1) 8 inch round flanged inlet in cover at drive end for the dried solids return conveyor; two (2) 24 inch diameter manways and two (2) 6 inch sight glasses along one side of cover; and one (1) 20 inch diameter plate flange for the vapor port in cover top at location where majority of steam vapors form.

8. Provide four (4) dried product discharge paths, two (2) bottom discharge flange with slide gate for cleanout to the discharge screw conveyor, one separate flanged connection in bottom of dryer for emergency discharge of material with manual slide gate; and for normal operation one (1) side discharge flange with adjustable weir to discharge screw conveyor.

9. Provide four (4) flanged connections near bottom for thermocouples that penetrate through the jacket and trough. Trough end heads shall be designed to permit vertical removal of agitator shafts. Provide a sparge water manifold with individual spray nozzles to encompass the entire length of the dryer in the event of upset or emergency conditions.

10. The assembly shall be a closed system to minimize air leakage through feed inlet, product discharge, and other paths.

11. Insulate dryer, except at ends, to minimize heat loss and to protect operating personnel. Provide a 2-inch blanket or block insulation, banded to trough and covered with 0.024 thick Type 304 stainless steel sheathing. Insulate cover using a fiberglass fabric which sandwiches a layer of insulation and attaches with Velcro tabs for easy removal of the cover for maintenance. Insulate each 24-inch access door with an independent blanket for easy removal. Refer to safety requirements indicated in other parts of this specification.

12. Agitator assemblies shall be designed and positioned to promote local mixing and agitation of the process mass, with the sludge transported down the length of the trough by displacement due to the continuous addition of feed sludge.

13. Design, manufacture, inspect, test, and stamp agitator assemblies in accordance with ASME Code for Unfired Pressure Vessels, Section VIII, Division I, for a

maximum design pressure of 125 psig and a design temperature of 550 degrees F.

14. Each assembly shall consist of a number of discontinuous wedge-shaped paddles mounted on a central hollow pipe acting as the primary structural member of the agitator shaft, and located symmetrical through the plane, which is perpendicular to the rotational axis of the agitator shaft. Paddles shall be hollow to permit flow of thermal fluid throughout.

15. Agitator shafts shall be carbon steel with Type 316L stainless steel cladding for all wetted parts for corrosion protection.

16. Construct paddles of Type 316L stainless steel, with paddles from three-fourths of the length to the discharge end provided with hard surfacing. Hard surfacing shall consist of 0.125 inches thick weld applied chromium carbide alloy with a minimum HRC hardness of 56, or 100 microns of HVOF applied tungsten carbide with a minimum HRC hardness of 65, or Owner approved equal. For paddles with hard surfacing, all paddle surface areas facing in the direction of rotation shall be hard surfaced, within one inch of the shaft.

17. Support each agitator shaft at its trunnion ends by self-aligning double row spherical roller bearings, minimum B-10 life of 100,000 hours, and mounted in split case pillow blocks. Housings shall be of cast iron with grease fitting for lubrication using high temperature grease.

18. Drive agitator shafts using a 150 HP motor top-mounted to a shaft-mounted reducer. The reducer will be mounted to the drive agitator and transmitting rotation and torque to the driven agitator through a set of spur gears rotating in an oil bath gear case. Final shaft speed will be approximately 6 rpm.

19. Arrange the non-driven trunnion ends to allow for circulation of thermal fluid into and out of the agitator through a rotary joint. Weld trunnion ends to the hollow shaft, and provide shaft trunnions with replaceable wear sleeves in the area where stuffing boxes are located.

20. Portable Bin: A portable bin (for off-spec discharge) constructed of a watertight and continuous welded with a minimum steel thickness of 14-gauge. Steel surfaces shall be powder coated. Bin shall be provided with two roller bearing wheels and two swivel wheels. Acceptable manufacturers shall be Valley Craft “F89680”, or equal.

21. Provide a single mounting base for the dryer, including support for the jacketed trough, pedestals for the agitator pillow blocks, and a base for the drive assembly components.

22. Provide compressed air to shafts on either side of dryer. Each airline supply shall include a pressure reducing valve, a pressure indicator and a rotameter.

C. Paddle Dryer Foundation and Plinth

1. The paddle dryer foundation and plinth shown on the Structural Drawings is designed based on a combined operating dead load of 226 kips and the dryer shall not exceed this weight.

D. Materials of construction

1. Trough and cover: Type 304L stainless steel

2. Insulation of trough: 2-inch blanket or block insulation covered with 0.024 thick Type 304 stainless steel sheathing.

3. Insulation of cover: fiberglass fabric which sandwiches a layer of insulation and attaches with Velcro tabs for easy removal of the cover for maintenance.

4. Agitator shafts: Carbon steel with Type 316L stainless steel cladding and hard surface coating.

5. Agitator paddles: Type 316L stainless steel

   a. Paddle surface coating: 0.125 inches thick weld applied chromium carbide alloy, or 100 microns of HVOF applied tungsten carbide, or Owner approved equal

6. Dryer assembly mounting base: carbon steel.

E. Controls

1. Controls shall be supplied in accordance with Section 11000 and as specified herein .

2. The dryer shall be provided with the following instrumentation at a minimum, to send a signal back to the dryer control system for monitoring and system control:

   a. Dryer agitator drive current.
   b. Dryer gas pressure transmitter below cover per Section 13434.
   c. Four trough material temperature transmitters.
   d. Dried solids discharge temperature transmitter per Section 13435.
   e. Sludge discharge high level switch.
   f. Dryer spray water valve actuation indication.
   g. Two position switches and junction box for the deflagration panels.
   h. Discharge weir gate position: low positon switch, high position switch, and position transmitter.
   i. Dryer motor high temperature switch (integral with motor).
   j. For variable speed dryer drive, speed indication.

3. In addition to the instrumentation specified above, the dryer shall be provided with the following instrumentation to provide local indication:

   a. Three (3) thermal fluid temperature gauges.
   b. Four (4) pressure gauges for dryer shaft seals.
   c. Four (4) pressure gauges on the compressed air supply to the dryer shaft seals.
   d. Four (4) rotameters on the compressed air supply to the dryer shaft seals.

F. Motor: Provide motor to drive agitator shafts. Motor shall be capable of producing a final shaft speed of approximately 6 rpm.

1. A variable speed motor shall be provided for the dryer drive motor.

2. Motor: Shall be in accordance with Section 16220 Low Voltage Motors and as specified herein. Motors shall be listed for installation in a NEC Class II, Division 2, Group G area and a NEC T Code of T3.. Where driven by a variable frequency drive, motors shall be inverter duty rated per the requirements of NEMA MG-1.

G. Spare parts:

1. Trough material temperature sensor.

2. One set of gaskets for trough cover and manway.

3. Expansion joint for dryer thermal fluid connection.

4. One set of flexible hoses and gaskets for agitator rotary joints.

5. One change of lubrication oil for each gear box.

6. Eight packing rings for agitator shaft seals.

2.5 THERMAL FLUID HEATING SYSTEM

A. General –Provide a thermal fluid heating system for supplying heating requirements of the dryer, including fluid pump (52-P-01-TF), fluid cooler (52-ME-02-TF), expansion tank (52-T-01-TF), , thermal fluid overflow tank and auxiliary items. Thermal fluid shall be pumped to the thermal fluid heater, fluid cooler, and paddle dryer. The nitrogen system shall be provided with two scales (52-ME-01-NIT and 52-ME-02-NIT).

B. Performance requirements

1. The thermal fluid system shall meet the requirements of the latest edition of NFPA 30 Flammable and Combustible Liquids Code.

2. The thermal fluid system shall be designed to operate with and be supplied with thermal fluid having a closed cup flash point of 410 degrees Fahrenheit, above the operating temperature of the thermal fluid system, which shall not exceed 390 degrees Fahrenheit (Class IIIB combustible liquid per the International Fire Code). The flash point of the fluid shall be determined by appropriate test procedure and apparatus as specified in ASTM D56, ASTM D 93 or ASTM D 3278. The Operations and Maintenance Manual shall identify that thermal fluid used in the system meets the requirements in this paragraph.

3. The thermal fluid expansion tank shall be a horizontal type designed and manufactured in accordance with NFPA 30 and shall meet the standards of either API 620 or ASME Code for Unfired Pressure Vessels, Section VIII, Division 1. The shell shall have two supports suitable for mounting on concrete pad foundations. The tank shall be sized for a minimum 1.5 times the total thermal expansion volume of thermal fluid in all components of the system. All necessary connections shall be provided for piping, vents, drains, and instruments.

   The thermal fluid expansion tank is located on the roof of the Thermal fluid Room and roof is designed based on the combined operating weight of the expansion

tank being 10 kips. The Contractor shall inform the Engineer if the expansion tank's combined operating dead load exceeds this weight.

4. The expansion tank shall be provided with nitrogen blanketing system to minimize oxidation of the thermal fluid. The tank shall be provided with suitably sized vacuum and pressure relief valves. The pressure relief valves shall be vented and the relief vent line shall terminate as indicated on the Drawings. A sign or marking meeting the requirements of NFPA 704 shall be applied to the expansion tank.

5. The nitrogen blanketing system shall include two nitrogen cylinders and valves and instrumentation, including a pressure reducing valve, check valve, a pressure gauge, and a pressure relief valve. Settings for valves shall be provided by the Dryer System Supplier. Each nitrogen cylinder shall be 230 cubic feet at 2200 psig operating pressure. Nitrogen cylinders and auxiliary equipment shall conform to applicable safety requirements of OSHA, United States Department of Transportation, and Compressed Gas Association, and NFPA. The nitrogen cylinders shall be provided with integral pressure reducing valve capable of reducing the discharge pressure to no greater than 800psig or lower as required for proper operation of the pressure reducing valve controlling flow into the thermal fluid expansion tank.

   Each nitrogen cylinder shall have one electronic load cell scale of the digital type, suitable for weighing the cylinder, shall be furnished and installed as indicated on the drawings. The scale shall have total weighing capacity of 30 pounds and shall be designed for floor surface mounting. The scale shall include a digital electronic indicator with capability of transmitting a loop powered 4-20 mA dc signal to the plant control system. The indicator shall have the capability of displaying net, gross, and tare weights. The indicator shall include a digital keyboard for indicator programming and tare weight entry. The indicator shall be programmable to indicate 0 to 30 pounds in 1-pound increments. The indicator shall alarm at low nitrogen weight as determined by the Dryer System Supplier for suitable nitrogen supply pressure for blanketing system.

   The scale shall be Eagle Microsystems "LP4200 Platform Scale" with "EI 1000 Indicator" or Force Flow Equipment "Model 40-DR30LP Scale" with "Wizard 4000 Indicator".

6. The thermal fluid cooler shall be a shell and tube type heat exchanger sized to cool and regulate the fluid in the hot thermal fluid system and shall be suitable for use with plant utility water for the cooling medium. The heat exchanger shall be sized using appropriate fouling factors for thermal fluid and plant effluent. The fouling factor for plant effluent shall in no case be less than 0.005 hr-sq ft-F/Btu.

   The System Supplier shall design the utility water feed system so that water that is normally feeding directly into the dryer off-gas condenser is re-directed to feed the thermal fluid cooler prior to looping back around to the dryer off-gas condenser during dryer shutdown operation. Pneumatic control valves shall be provided to perform this function and shall be timed so that the condenser drainage temperature does not exceed 120 ºF.

   The System Supplier shall supply a pneumatically actuated control valve to regulate the flow of thermal fluid through the thermal fluid cooler.

7. The shell and tube type exchanger shall be designed to ASME Section VIII requirements. The heat exchanger shall bear the ASME stamp for unfired pressure vessels.

8. The shell and tube type heat exchanger shall be horizontal tube type with removable tube bundle with cold fluid circulation through the tubes. The exchanger shall be constructed with fabricated channels at each end. Channels shall have flanged and bolted covers which can be removed without disturbing any piping connections.

9. The shell shall be of welded construction and include provisions for expansion of one of the tube sheets and channels if required by the manufacturer's design for the specified conditions. Shells shall have two supports suitable for mounting on concrete pad foundations. All necessary connections shall be provided for piping, vents, drains and instruments.

10. Tubes shall be rolled into the tube sheets and shall be adequately supported to prevent sagging or vibration. The method of expanding the tubes shall be such as to not change the size of the tube sheet opening. The tube bundle supports shall be arranged as baffles to obtain the most effective distribution of the fluid above and around the entire tube bundle.

11. A relief valve shall be furnished on each liquid side of the fluid cooler. Relief valves shall have manual lifting levers and shall be capable of protecting the exchanger from overpressure in the event the exchanger is operated with closed isolation valves. The relief valve shall be piped to the thermal fluid overflow tank.

12. The thermal fluid pump shall be a centrifugal horizontal end suction type, with enclosed impeller, driven by an electric motor through a flexible coupling. The pump casing shall be rated for 75 psig at 500°F (or greater if required by the System Supplier's design). Pump casing shall be constructed of ASTM A395 ductile iron and pump impeller shall be constructed of cast iron. All rotating parts shall be accurately machined and shall be in as nearly perfect rotational balance as practicable. The unfiltered vibration velocity, as measured at any point on the machine including the motor, shall not exceed the maximum vibration limits of the Hydraulic Institute. The pump shall have a minimum pump efficiency of 65% at the rated head and flow. The pumping unit shall be complete with a pump, electric motor, anchor bolts, and other appurtenances specified or otherwise required for proper operation. The design shall incorporate the pressure drop for the entire thermal fluid system, including the thermal fluid piping as laid out on the Drawings.

13. The thermal fluid overflow tank shall be a horizontal type designed and manufactured in accordance with NFPA 30 and shall meet the standards of either API 620 or ASME Code for Unfired Pressure Vessels, Section VIII, Division 1. The shell shall have two supports suitable for mounting on concrete pad foundations. The tank shall have a minimum capacity of 60 gallons. All necessary connections shall be provided for piping, vents, drains, and instruments including, but not limited to, one drain connection, four PRV relief connections, and one vent connection. The tank, supports, and anchorage shall be designed by the System Supplier

14. Provide stainless steel flexible hose for connections to thermal fluid equipment components. The flexible hose shall be rated for 550°F and 125 psig and shall be

the appropriate length to meet the minimum bend radius requirements of the hose. Hose shall be Hose Master “Masterflex Series” or equal.

15. Provide a local control panel for the thermal fluid heating system.

16. The thermal fluid cooler activation control valve and utility water control valve shall be actuated by a compatible vane type pneumatic actuator and shall be provided by the valve manufacturer and include the following requirements:

    a. The vane type actuator shall be sized to provide a safety factor of 25% for open-close service and 50% for modulating service, shall be designed to provide satisfactory operation using dry, oil free instrument air at 80 psig pressure, and shall be shop tested at 225 psig. Pneumatic vane type actuators shall be as manufactured by Kinetrol, Ltd. or K-Tork International, without exception.
    b. Actuator shaft and vane shall be a single machined part. Vane lip seals shall be constructed by the dual opposed injection molded method. Stainless steel expanders shall be fitted beneath the vane lip seals to ensure continual seal-to-case contact. All actuators shall be fitted with stainless steel threaded travel stops allowing adjustment at each end of actuator stroke.
    c. Vane actuators shall be configured such that on power failure, the spring shall drive the valve open or closed determined by the Dryer System Supplier based on the functional requirements of the system. Springs shall be clock type. Each actuator shall be furnished with a 3 way solenoid valve. A flow control valve shall be furnished and installed in the solenoid valve vent.
    d. Actuator manufacturers shall have 5 years experience with the spring return model to be provided and shall furnish references with contact information on request. Each actuator shall be factory assembled with piping and all required accessories including solenoid valve, positioner, flow control valves, and other accessories required for a properly operating system

C. Materials of construction

1. Thermal fluid expansion tank and thermal fluid overflow tank: tank shell shall be constructed of SA 36 or SA 516 Grade 70 carbon steel

2. Thermal fluid pump casing: ASTM A395 ductile iron

3. Thermal fluid pump impeller: cast iron

D. Controls

1. Controls shall be supplied in accordance with Section 11000 and as specified herein

2. The thermal fluid system shall be provided with the following instrumentation, to send a signal back to the dryer control system for monitoring and system control:

    a. Expansion tank low pressure switch per Section 13434.
    b. Expansion tank low and high level switch per Section 13433.

c. Thermal fluid cooler discharge temperature transmitter per Section 13435.
d. Thermal fluid cooler activation pneumatic control valve.
e. Thermal fluid pump run indication.
f. Thermal fluid pump temperature switch high per Section 13435
g. Emergency stop

3. A local emergency stop button shall be provided for the heater and shall be located as indicated on the P&IDs.

4. The thermal fluid system shall be provided with the following instrumentation to provide local indication:

a. Expansion tank level indicator.
b. Expansion tank pressure indicator.
c. Thermal fluid cooler return pressure gauge.
d. Thermal fluid cooler supply cooling water pressure gauge.
e. Thermal fluid pump discharge fluid flow.
f. Thermal fluid pump inlet and discharge pressure gauges.
g. Thermal fluid cooler discharge cooling water temperature gauge

E. Motor: Pump motor shall be in accordance with Section 16220 Low Voltage Motors. Where operated from a variable frequency drive the motor shall be inverter duty rated per NEMA MG-1. .

F. Spare Parts: One set of pump bearings

2.6 THERMAL FLUID HEATER

A. General - <52-ME-01-TF> Provide one (1) thermal fluid heater to provide heat to the dryer, including a combustion fan (52-F-01-TF).

B. Performance Requirements

1. Heater shall be of a forced circulation design and designed and stamped according to the specifications of the ASME Section 1 - Pressure Vessel Code for 150 psig at 750°F. The heater shall meet the requirements of NFPA 87 Recommended Practice for Fluid Heaters.

2. Heater shall be pressure tested at 225 psig.

3. Heater inlet and outlet connections shall be ANSI 300 pound flanged and fitted with thermowells to monitor the heater inlet and outlet temperatures.

4. Design the heating coils to have sufficient fluid velocities to ensure maximum permissible film temperature of the fluid is not exceeded.

5. Externally insulate the shell with a minimum of two inches of mineral wool insulation or internally insulate the shell with rigid ceramic fiber blanket, to prevent heat loss radiation, accidental injuries and overheating of the working environment. For equipment and piping not insulated herein refer to Section 15800.

6. Heater shall include a pressure relief valve sized for ASME Section 1 liquid with a 300 pound inlet flange and 150 pound outlet flange. The relief valve shall be piped to the thermal fluid overflow tank.

7. The heater shall be designed for use with a burner type as specified herein, suitable for use with natural gas being supplied from the plant at a pressure of 2 psi.

8. The forced draft type burner shall be modulating, with 5:1 turndown ratio, low fire start, power gas type, designed to burn the type of fuel without vibration, noise, or pulsations. Burners shall be UL listed. The burner shall incorporate a stainless steel flame retention type combustion head and shall be equipped with an external primary-secondary air ratio adjustment and total air volume adjustment. A permanent observation port shall be provided to allow observation of both pilot and main flames. The burner shall be equipped with a forced draft air fan sized to supply the air required for proper combustion of the specified fuel. The unit shall be equipped with an airflow switch to shut off the fuel supply upon failure of the combustion air.

9. The complete fuel burning assembly shall conform to the requirements of UL, and FM. The fuel train shall consist of pressure regulators, shutoff valves, gas valves, high and low gas pressure switches, and vent valves. The fuel train piping shall include 1/4 inch [6 mm] pressure tappings with pipe plugs upstream and downstream from each valve and regulator.

10. Burner shall be fully modulating, forced draft burner with 5:1 turndown ratio on natural gas. The burner, fan, motor and fuel train shall comply with applicable nationally recognized testing laboratories (NFPA, Factory Mutual and UL regulations).

11. The flame safety system shall be an ultraviolet sensitive flame detector and burner sight glass, directly viewable from the floor level without the use of mirrors or other devices. The flame safeguard shall provide automatic burner sequencing, flame supervision, system status indication, system or self-diagnostics, and troubleshooting with an alpha-numeric characterized read-out that displays the recent combustion faults.

12. A differential pressure switch (or transmitter) with indication, shall continuously monitor flow based on differential pressure at the thermal fluid heater outlet and shall shut off the burner if the flow drops below 90% of the design value.

13. The heater shall be supplied with a natural gas valve train. Each valve train shall include all supply valves, pressure regulators relief valves and vents, safety shutoff valves, pressure relief valves, pressure gauges, and pressure switches required for a complete operating system and shall comply with all applicable codes.

14. Gas Vent Systems

    a. A gas vent systems shall be provided for the heater exhaust. Drain tee caps, stack caps, storm collars, and equipment connection kits shall be provided. The systems shall be designed to compensate for all flue gas-induced thermal expansions. Supports, guides, and all appurtenances required for a complete system shall be furnished at locations determined

by the flue systems manufacturer. The entire system from each boiler to the termination, including accessories, shall be from one manufacturer.

b. Gas vent system materials and construction shall be in accordance with the vented equipment manufacturer's recommendations and instructions and to any local codes which pertain to such work.

c. Factory built gas vent piping and fittings shall be laboratory tested, listed by Underwriters' Laboratories, and shall comply with NFPA 211. The materials and construction of the modular sections shall meet the terms of the product UL listing.

d. Chimney and vent systems for category II, III, and IV equipment with vents 6 inch and larger shall be Selkirk Metalbestos "Type PS" gas vent or Metal Fab "Model PIC". The vent pipe and fittings shall be of double wall construction with a nominal 1 inch air space between the walls. The inner gas-carrying pipe shall be constructed of at least 0.035 inch AISI Type 316 stainless steel and the outer jacket shall be constructed of at least 0.024 inch aluminum coated steel for interior locations and AISI Type 316 stainless steel for the portions of the stack exposed to the outdoor environment.

15. The thermal fluid heater shall conform to the BAAQMD requirements for boiler certification under Regulation 9, Rule 7. If the submitted boiler is not currently included on the BAAQMD certified boiler list, then the System Supplier shall certify the submitted thermal fluid heater per the BAAQMD requirements. At a minimum, the System Supplier shall perform a factory test and submit the required data to BAAQMD for their review and acceptance: however, the System Supplier is responsible for satisfying all requirements for obtaining certification through the BAAQMD.

16. Provide a local control panel for the thermal fluid heater meeting panel construction requirements as specified in Section 11000.

C. Controls

1. The thermal fluid heater system shall also contain the following control devices:

   a. High thermal fluid temperature switch.
   b. Low combustion air switch.
   c. Temperature sensors (for Thermal Fluid Supply & Return).
   d. One pressure relief valve (ASME Section 1).
   e. One low fluid level switch..
   f. Flame safeguard control.
   g. One low thermal fluid flow switch (based upon discharge pressure at pump).

2. The thermal fluid heater control panel shall contain a minimum of the following independently labeled fault lights:

   a. High thermal fluid temperature
   b. High flue gas temperature
   c. Low thermal fluid level in expansion tank
   d. Low thermal fluid flow
   e. Burner or flame failure

3. The control panel shall include a module remote Start/Stop, Remote/Local switch and remote cycling contacts to allow for remote temperature set point and control. Remote control operation shall be provided from the System PLC control system.

4. A flowmeter shall be provided for the natural gas fuel supply.

   a. The flowmeter shall be a thermal dispersion type, explosion-proof, and stainless steel or Hastelloy C sensing element installed in the process piping. The insertion length of the element shall be approximately one-half of the pipe diameter, and all mounting accessories shall be provided. The sensor shall have a 1 inch MNPT mounting connection, and an isolation valve and packing gland that allows insertion and removal while the piping is under pressure.
   b. The electronic transmitter shall be remotely mounted within 30 feet of the sensor with interconnecting cable provided. The transmitter shall be of the ac-powered type. The unit shall be housed in a NEMA Type 4 enclosure. The transmitter shall have a 4 20 mA dc analog output and a local indicator with a multi-line LCD display calibrated in engineering units of flow. The transmitter shall also display a totalized flow value and the temperature of the process fluid.
   c. Accuracy of the flowmeter shall be 1 percent of full scale over a 20-to-1 operating range. The flowmeter shall be Fluid Components International “ST Series”; Kurz Instrument “454 Series”, STI Magnetrol Environmental “Model TA2”; Sierra Instruments, Inc. “640S Series Steel-Mass”, Sage Metering, Inc.; or Thermal Instrument Company “Model 62-9/9500”.

D. Spare Parts: One burner flame detector

E. Manufacturers or Equal

1. Thermal fluid heater: Vapor Power International, Fulton, or approved equal.

2. Flame safeguard: Honeywell RM7800, Siemens LMV, or approved equal,

2.7 DRIED SOLIDS SCREW CONVEYORS

A. General – Provide one (1) dryer discharge screw conveyor (52-ME01-DRS). and one (1) dried solids return conveyor (52-ME-11-DRSR) and return rotary valve (52-V-11-DRSR) to recycle off-spec dried solids that are over and under the target size from the vibrating screen to dryer inlet..

B. Performance Requirements

1. Product exiting the dryer shall fall by gravity into the dryer discharge screw conveyor. If required by the System Supplier design, the discharge shall be provided with a rotary valve.

2. Product exiting the dried solids return conveyor shall fall by gravity into the dryer. If required by the System Supplier design, the discharge shall be provided with a rotary valve.

3. Refer to Paragraph 2.16 for rotary valve requirements.

4. Provide inlet connections to match the dryer discharge slide gates.

5. Dryer discharge screw conveyor shall be provided with a hinged drop bottom opening that has a minimum length of 3'-0". This shall provide an alternative way to remove dried product from the dryer.

6. The discharge conveyor trough shall use a flared design to prevent necking down in the discharge chute.

7. Material exiting the discharge conveyor shall discharge directly to the cooling conveyor described below.

8. The dryer discharge screw conveyor shall be designed so that the maximum operating speed does not exceed 25 rpm.

9. The dried solids return conveyor shall be designed so that the maximum operating speed does not exceed 45 rpm.

10. Conveyors shall be designed to be dust tight. Conveyors inside structures shall be designed for a CEMA enclosure classification IIIE and conveyors outside structures shall be designed for a CEMA enclosure classification IVE.

11. Screws for shafted conveyors shall consist of sectional or helicoil flights connected to a shaft with intermittent welds and welded lugs. Flighting thickness shall be designed for the maximum torque requirements of the equipment specified but shall not be less than 1/4 inch for conveyors with less than 6-inch diameter, 3/8-inch for conveyors with 9 to 14-inch diameter, and ½-inch for conveyors with 16 to 24-inch diameter. The flights shall be mounted to a pipe of sufficient diameter so as to maintain a maximum deflection of less than 1/8 inch between trough ends and any intermediate hanger bearing assemblies. The shaft shall have a minimum thickness equivalent of schedule 80 pipe for the diameter provided.

12. Troughs shall be similar to the dimensional standards of CEMA 300-09. The outlet openings in the trough bottom shall be sized to prevent screw conveyor plugging.

13. The portion of each trough that is not covered by the filling chute shall be covered by a minimum 12 gage flanged and bolted cover for safety and odor/dust control and shall be similar to CEMA Standard No. 300-23. The trough covers shall have connections for takeoffs to the fugitive dust system as required.

14. Drive, tail end, and coupling shafts shall be provided in accordance with CEMA 300. Bushings shall be provided inside the screw pipe shaft to accept the shafts. The shafts shall be attached to the screw pipe shaft with a minimum of two coupling bolts. Shaft roller bearings shall have a minimum ABMA L10 life rating of 50,000 hours.

15. End shaft bearings shall be roller bearing pillow blocks. Intermediate hanger bearings and journals shall be stellite or ceramic coated.

16. Each conveyor shall be furnished complete with supports suitable for mounting as required by the System Supplier's design. At a minimum, each screw conveyor trough shall have supports at the drive end and the tail end of the trough plus intermediate supports at a maximum of 12 foot intervals. All shop welding shall conform to the latest standards of American Welding Society (AWS). The

supports shall be designed to avoid interference with other equipment or equipment supports. The supports shall be designed to prevent excessive vibration of any portion of the conveyor unit under all loading conditions.

17. Conveyor supports shall be designed for a minimum live load as specified herein. All structural supporting members shall be designed such that the ratio of the untraced length to least radius of gyration (slenderness ratio) shall not exceed 120 for any compression member and shall not exceed 240 for any tension member (of angles about Z Z axis). In addition, all structural members and connections shall be designed so that the unit stresses will not exceed the AISC allowable stresses by more than 1/3 when subject to loading of twice the maximum design operating torque of the screw conveyor drive motors.

18. Each conveyor shall be driven by an electric motor through a direct drive gear reducer. Drive units shall be designed for 24 hour continuous service.

19. All gear reducers shall be AGMA Class II, single or double reduction, helical gear units with high capacity roller bearings. Bearings shall be designed for the thrust loads from the spiral flights and shall have a minimum ABMA L10 life rating of 50,000 hours.

20. External lubrication points, easily accessible, shall be furnished for all conveyors. Screw conveyor drives shall be sized to start in a fully loaded condition.

21. Conveyor manufacture shall provide safety equipment and safety guards as required by OSHA and as indicated in ASME B20-1, Safety Standards for Conveyor and Related Equipment.

C. Materials of Construction

1. Discharge screw conveyor: all wetted surfaces shall be Type 304 stainless steel.

2. Recycle screw conveyor: all wetted surfaces shall be Type 304 stainless steel.

D. Controls

1. Controls shall be supplied in accordance with Section 11000 and as specified herein.

2. Each load out conveyor shall be provided with the following instrumentation to send a signal back to the dryer control system for monitoring and system control:

   a. Motor operating status.
   b. Motor high temperature switch integral with motor.
   c. Zero speed switch located at the opposite conveyor end from the drive.
   d. Plug detection based on power/current draw, which will shut off power to the conveyor and sound an alarm.
   e. Variable speed screw conveyors, speed indication.
   f. Zero speed switch for conveyors

E. Motor:

1. A variable speed controller shall be provided to each dried solids conveyor.

2. Shall be in accordance with Section 16220 Low Voltage Motors and as specified herein. Motors shall be listed for installation in a NEC Class II, Division 2, Group G area and a NEC T Code of T3. Where operated from a variable frequency drive the motor shall be inverter duty rated per NEMA MG-1.

F. Spare Parts: One of each size and type of bearings.

2.8 DRIED SOLIDS CONVEYORS (COOLED)

A. General – <52-ME-02-DRS, 52-ME-03-DRS> Provide maximum of two (2) dried solids cooling conveyor.

B. Performance Requirements

1. Dried product will be cooled in multiple shafted indirect cooling screw conveyors.

2. The cooling conveyor(s) shall be capable of receiving the dried biosolids at a maximum temperature of 280°F and cool the biosolids to the temperature indicated in the Paragraph 2.H.1 or lower. The System Supplier shall be responsible for coordinating the location of the cooling conveyor and the drag chain conveyor if different cooling conveyor lengths are required. Conveyor supports shall be designed by the System Supplier.

3. The cooling conveyor shall be water jacketed to use utility water as the cooling media (see maximum utility water temperature provided herein). The cooling water shall not contact or otherwise contaminate the dried product. Flanged connections shall be provided for the water connections. The maximum flow rate of cooling water shall be 60 gpm.

4. The conveyor shall be powered by a variable speed motor, if required by the System Supplier's design. Variable frequency drive, if required, will be located in the MCC provided by the Dryer System Supplier and as specified in Section 16442.

5. Dryer System Supplier's design shall maintain levels in the cooling conveyors.

6. Conveyor screws shall be designed so that the maximum operating speed does not exceed 25 rpm.

7. Conveyors shall be designed to be dust tight. Conveyors inside structures shall be designed for a CEMA enclosure classification IIIE and conveyors outside structures shall be designed for a CEMA enclosure classification IVE.

8. Screws for shafted conveyors shall consist of sectional or helicoil flights connected to a shaft with intermittent welds and welded lugs. Flighting thickness shall be designed for the maximum torque requirements of the equipment specified but shall not be less than 1/4 inch for conveyors with less than 6-inch diameter, 3/8-inch for conveyors with 9 to 14-inch diameter, and ½-inch for conveyors with 16 to 24-inch diameter. The flights shall be mounted to a pipe of sufficient diameter so as to maintain a maximum deflection of less than 1/8 inch between trough ends and any intermediate hanger bearing assemblies. The shaft shall have a minimum thickness equivalent of schedule 80 pipe for the diameter provided.

9. The outlet openings in the trough bottom shall be sized to prevent screw conveyor plugging.

10. Drive, tail end, and coupling shafts shall be provided in accordance with CEMA 300. Bushings shall be provided inside the screw pipe shaft to accept the shafts. The shafts shall be attached to the screw pipe shaft with a minimum of two coupling bolts. Shaft roller bearings shall have a minimum ABMA L10 life rating of 50,000 hours.

11. End shaft bearings shall be roller bearing pillow blocks. Intermediate hanger bearings and journals shall be stellite or ceramic coated.

12. Each screw conveyor shall be furnished complete with supports suitable for mounting as required by the supplier's design. At a minimum, each screw conveyor trough shall have supports at the drive end and the tail end of the trough plus intermediate supports at a maximum of 12 foot intervals. The supports shall be designed to prevent excessive vibration of any portion of the conveyor unit under all loading conditions.

13. Each conveyor shall be driven by an electric motor through a direct drive gear reducer. Drive units shall be designed for 24 hour continuous service.

14. All gear reducers shall be AGMA Class II, single or double reduction, helical gear units with high capacity roller bearings. Bearings shall be designed for the thrust loads from the spiral flights and shall have a minimum ABMA L10 life rating of 50,000 hours.

15. External lubrication points, easily accessible, shall be furnished for all conveyors. Screw conveyor drives shall be sized to start in a fully loaded condition.

16. Conveyor manufacture shall provide safety equipment and safety guards as required by OSHA and as indicated in ASME B20-1, Safety Standards for Conveyor and Related Equipment.

17. Each conveyor shall be furnished complete with supports suitable for mounting as required by the supplier's design. At a minimum, each screw conveyor trough shall have supports at the drive end and the tail end of the trough plus intermediate supports at a maximum of 12 foot intervals. All shop welding shall conform to the latest standards of American Welding Society (AWS). The supports shall be designed to avoid interference with other equipment or equipment supports. The supports shall be designed to prevent excessive vibration of any portion of the conveyor unit under all loading conditions.

18. Conveyor supports shall be designed for a minimum live load as specified herein. All structural supporting members shall be designed such that the ratio of the untraced length to least radius of gyration (slenderness ratio) shall not exceed 120 for any compression member and shall not exceed 240 for any tension member (of angles about Z Z axis). In addition, all structural members and connections shall be designed so that the unit stresses will not exceed the AISC allowable stresses by more than 1/3 when subject to loading of twice the maximum design operating torque of the screw conveyor drive motors.

C. Materials of Construction

1. Cooling conveyor shall be Type 304 stainless steel for all wetted surfaces.

D. Controls

1. Controls shall be supplied in accordance with Section 11000 and as specified herein.

2. A high temperature transmitter shall be installed in the conveyor to detect abnormally high temperatures and shall be provided as specified in Section 13435.

3. Each dried solids conveyor (cooled) shall be provided with the following instrumentation to send a signal back to the dryer control system for monitoring and system control:

   a. Motor operating status.
   b. Motor high temperature switch integral with motor.
   c. Zero speed switch located at the opposite conveyor end from the drive.
   d. Plug detection based on power use, which will shut off power to the conveyor and sound an alarm.
   e. For variable speed screw conveyors, speed indication.
   f. Temperature indicating transmitter on Dried Solids Conveyor 3.
   g. Flowmeter and flow indicating transmitter shall be provided on the cooling water line prior to discharging into the floor drain. Provide in accordance with Section 13432.

4. In addition to the instrumentation specified above, a temperature gauge shall be provided on Dried Solids Conveyor 2.

E. Motors

1. A variable speed motor shall be provided to drive each cooling conveyor.

2. Motor: Shall be in accordance with Section 16220 Low Voltage Motors and as specified herein. Motors shall be listed for installation in a NEC Class II, Division 2, Group G area and a NEC T Code of T3. Where operated from a variable frequency drive the motor shall be inverter duty rated per NEMA MG-1.

F. Spare Parts: One of each size and type of bearings.

2.9 DRIED SOLIDS SCREEN

A. General - <52-ME-05-DRS> - One (1) vibrating dried solids screen shall be provided to classify the dried solids.

B. Performance Requirements

1. Screen shall be sized per the process requirements of the dryer system design requirements.

2. The vibrating screen shall be 40 inch diameter and shall have two decks with the first deck classifying all particles larger than 8 mm using a 5/16” screen and discharging them to the off -spec return conveyor. The second deck shall classify all particles less than 1.0 mm (fines) using an 18-mesh market grade screen.

These particles shall also be returned to the dryer by the Dried Solids Return Conveyor. Product having particle sizes between 1.0 mm and 8 mm will be discharged directly into the dried solids cooling conveyor.

3. The screen shall have a 13-inch diameter inlet connection and a 2-inch diameter vent connection located in the cover of the screen. The screen outlet connections shall include separate 8-inch diameter connections for acceptable product discharge, recycled product and tramp material.

4. The trap material discharge shall be furnished with a diverter valve to permit removal of tramp material.

5. The screen shall include an anti-blinding device under the lower screen deck to aid in the removal of fibrous and near sized material.

6. The screen shall have flexible connections for the screen inlet, vent and discharge connections.

7. The screen cover shall have a 6-inch diameter inspection port with removable cover in the cover of the screen.

8. Screen and all necessary clamp rings, gaskets, dust cover assembly, and hardware shall be mounted on vibration isolation springs in turn mounted to a fixed carbon steel base. The screen shall be furnished with grounding lugs.

C. Materials of Construction

1. Product contact parts of the vibrating screener shall be fabricated from Type 304 stainless steel.

2. Screener assembly base: epoxy coated carbon steel

D. Controls

1. Controls shall be supplied in accordance with Section 11000 and as specified herein.

2. A safety switch with NEMA 7 enclosure shall be provided on the maintenance access door on the base of the vibrating screener. The switch shall be interlocked to shut down the screener when the door is opened.

3. The screen shall be provided with the following instrumentation to send a signal back to the dryer control system for monitoring and system control:

   a. Motor operating status.
   b. Motor high temperature switch.
   c. Screener position switch

E. Motor: Shall be in accordance with Section 16220 Low Voltage Motors and as specified herein. Motors shall be listed for installation in a NEC Class II, Division 2, Group G area and a NEC T Code of T3.

F. Spare Parts

1. One complete set of screens

2. Four sets of inlet and outlet hoses

G. Manufacturer or Equal

1. Kason, Andritz, or equal

2.10 DRIED SOLIDS DRAG CHAIN CONVEYOR

A. General <52-ME-04-DRS> - Provide one (1) drag chain conveyor assembly. Assembly shall include drag conveyor, drive system, supports, controls and safety accessories.

B. Performance Requirements

1. Conveyor shall be designed for continuous duty.

2. The dryer product transfer conveyor shall be a tubular drag chain conveyor.

3. Drag chain conveyor shall receive dried product from a flanged connection on the cooling screw conveyor.

4. Conveyor shall be provided with a sight glass on the return tube prior to entering into the conveyor.

5. Drag chain conveyor shall be fully enclosed except the loading and discharge ports.

6. The drag chain conveyor shall be self-cleaning to prevent dried product accumulation on any part of the conveyance system.

7. The conveyor shall be constructed of material appropriate for withstanding the abrasive and corrosive nature of dried biosolids.

8. The internals shall be of a non-sparking design for the handling of combustible particulate and dust.

9. The drag chain shall be drop forged carbon steel, rivetless chain and have two-piece replaceable UHMW-PE flights, spaced as recommended by the manufacturer for the design loading.

10. The drag chain conveyor housing shall include two (2) inspection openings for chain installation and inspection.

11. Housing bends shall be hardened to 600 BHN.

12. Provide chutes to connect between discharge flange on the cooling screw conveyor rotary valve of the dryer system to the loadout screw conveyor.

13. Drive assembly shall consist of an integral gearmotor. Gear housing shall be cast iron, furnishing complete protection under all conditions of service. Gears shall be manufactured and rated for continuous duty in accordance with AGMA Standards, of heat treated alloy steel.

14. Provide splash type gear lubrication.

15. Gear reducer shall be Class II speed reducer as manufactured by Eurodrive. The gear reducer and drive shall be designed to provide an applied torque adequate to start a full loaded conveyor.

16. Drive shall have an AGMA service factor of 1.4 and shall operate on 460V/3 phase/60 Hz power.

17. A hardened tooth drive sprocket for the conveying chain is keyed and set-screwed to the drive shaft. A jackscrew takeup mechanism shall be provided to take up slack in the chain.

18. An unbalanced load type chain vibrator and mild steel hammer assembly shall be mounted at conveyor discharge to minimize carry back.

19. The conveyor shall be furnished complete with supports suitable for mounting as required by the System Supplier's design. At a minimum, each conveyor shall have supports at the drive end and the tail end of the conveyor plus intermediate supports at a maximum of 10 foot intervals. All shop welding shall conform to the latest standards of American Welding Society (AWS). The supports shall be designed to avoid interference with other equipment or equipment supports. The supports shall be designed to prevent excessive vibration of any portion of the conveyor unit under all loading conditions. It is expected that the conveyor may need to be supported off of the metal building and the System Supplier shall coordinate the required supports with the Contractor’s metal building designer.

20. Conveyor supports shall be designed for a minimum live load as specified herein. All structural supporting members shall be designed such that the ratio of the untraced length to least radius of gyration (slenderness ratio) shall not exceed 120 for any compression member and shall not exceed 240 for any tension member (of angles about Z Z axis). In addition, all structural members and connections shall be designed so that the unit stresses will not exceed the AISC allowable stresses by more than 1/3 when subject to loading of twice the maximum design operating torque of the conveyor drive motors.

21. Provide baseplates at each ground support leg for anchor bolting.

22. Conveyor manufacture shall provide safety equipment and safety guards as required by OSHA and as indicated in ASME B20-1, Safety Standards for Conveyor and Related Equipment.

23. A compressed air connection to the drag conveyor shall be provided near the discharge opening to blow excess powder off of the discs. This line shall be provided with a pneumatic actuated ball or globe valve as required by the System Supplier.

C. Materials of Construction

1. Housing: Standard Schedule 40 mild steel.

2. Chutes: Standard mild steel minimum 3/16-inch.

3. Conveyor Supports: Galvanized, ASTM A153 and A385.

4. Hardware: All fasteners shall be stainless steel. Zinc plated fasteners shall not be used. All stainless steel bolts shall be assembled using an anti-seize compound. All structural bolts shall be stainless steel.

5. Control panels shall be NEMA 4X, stainless steel.

D. Controls

1. Controls shall be supplied in accordance with Section 11000 and as specified herein

2. Provide two E-Stop switches for conveyors.

3. The conveyor shall be provided with the following instrumentation to send a signal back to the dryer control system for monitoring and system control:

   a. Motor operating status.
   b. Motor high temperature switch integral with motor.
   c. Zero speed switch located at the opposite conveyor end from the drive.
   d. Plug detection based on power/current draw, which will shut off power to the conveyor and sound an alarm.
   e. For variable speed screw conveyors, speed indication.

E. Motor:

1. A variable speed motor shall be provided to drive the dried solids drag conveyor.

2. Shall be in accordance with Section 16220 Low Voltage Motors and as specified herein. Motors shall be listed for installation in a NEC Class II, Division 2, Group G area and a NEC T Code of T3. Where operated from a variable frequency drive the motor shall be inverter duty rated per NEMA MG-1.

F. Spare Parts: The following spare parts shall be furnished in substantial wooden boxes with identifying labels and delivered to the vicinity of the project site:

Spare Parts	Quantity
Chain Assembly	10 Ft.
Drive Shaft	1
Drive Sprocket	1
Idler Shaft	1
Idler Sprocket	1

G. Manufacturers or Equal

1. Hapman, Kalamazoo, MI.

2. Flexicon Corporation, Bethlehem, PA.

3. Spiroflow Systems, Inc., Monroe, NC.

4. Chain-vey, Modern Process Equipment Corporation, Chicago, IL.

2.11 DRIED SOLIDS LOAD OUT CONVEYOR

A. General - <52-ME-06-DRS> - One (1) load out conveyor shall be provided to transfer dry product from the drag chain conveyor to the telescoping discharge cutes. Three (3) telescoping discharge chutes (52-ME-07-DRS to 52-ME-09-DRS) shall be provided for dry product load out. Each telescoping chute shall be provided with an automatic slide gate with pneumatic actuator (52-G-01-DRS to 52-G-03-DRS) and a foul air butterfly valve with pneumatic actuator (52-V-01-DC to 52-V-03-DC).

B. Performance Requirements

1. Load out conveyor screw shall be designed so that the filling factor does not exceed 35 percent at a maximum operating speed of 45 rpm. Load out screw conveyor shall not be inclined at a greater than 30 degree angle.

2. Conveyors shall be designed to be dust tight. Conveyors inside structures shall be designed for a CEMA enclosure classification IIIE and conveyors outside structures shall be designed for a CEMA enclosure classification IVE.

3. Screws for shafted conveyors shall consist of sectional or helicoil flights connected to a shaft with intermittent welds and welded lugs. Flighting thickness shall be designed for the maximum torque requirements of the equipment specified but shall not be less than 1/4 inch for conveyors with less than 6-inch diameter, 3/8-inch for conveyors with 9 to 14-inch diameter, and ½-inch for conveyors with 16 to 24-inch diameter. The flights shall be mounted to a pipe of sufficient diameter so as to maintain a maximum deflection of less than 1/8 inch between trough ends and any intermediate hanger bearing assemblies. The shaft shall have a minimum thickness equivalent of schedule 80 pipe for the diameter provided.

4. Troughs shall be similar to the dimensional standards of CEMA 300-09. Each conveyor trough shall be U-shaped. Troughs shall be provided with replaceable UHMW wear liners. The outlet openings in the trough bottom shall be sized to prevent screw conveyor plugging.

5. The portion of each trough that is not covered by the filling chute shall be covered by a minimum 12 gage flanged and bolted cover for safety and odor/dust control and shall be similar to CEMA Standard No. 300-23.

6. Drive, tail end, and coupling shafts shall be provided in accordance with CEMA 300. Bushings shall be provided inside the screw pipe shaft to accept the shafts. The shafts shall be attached to the screw pipe shaft with a minimum of two coupling bolts. Shaft roller bearings shall have a minimum ABMA L10 life rating of 50,000 hours.

7. End shaft bearings shall be roller bearing pillow blocks. Intermediate hanger bearings and journals shall be stellite or ceramic coated.

8. Each conveyor shall be furnished complete with supports suitable for mounting as required by the supplier's design. At a minimum, each screw conveyor trough shall have supports at the drive end and the tail end of the trough plus intermediate supports at a maximum of 12 foot intervals. All shop welding shall conform to the latest standards of American Welding Society (AWS). The supports shall be designed to avoid interference with other equipment or

equipment supports. The supports shall be designed to prevent excessive vibration of any portion of the conveyor unit under all loading conditions.

9. Conveyor supports shall be designed for a minimum live load as specified herein. All structural supporting members shall be designed such that the ratio of the untraced length to least radius of gyration (slenderness ratio) shall not exceed 120 for any compression member and shall not exceed 240 for any tension member (of angles about Z Z axis). In addition, all structural members and connections shall be designed so that the unit stresses will not exceed the AISC allowable stresses by more than 1/3 when subject to loading of twice the maximum design operating torque of the screw conveyor drive motors. Supports shall be coordinated with the elevated platform design.

10. Each conveyor shall be driven by an electric motor through a direct drive gear reducer. Drive units shall be designed for 24 hour continuous service.

11. All gear reducers shall be AGMA Class II, single or double reduction, helical gear units with high capacity roller bearings. Bearings shall be designed for the thrust loads from the spiral flights and shall have a minimum ABMA L10 life rating of 50,000 hours.

12. External lubrication points, easily accessible, shall be furnished for all conveyors. Screw conveyor drives shall be sized to start in a fully loaded condition.

13. Each conveyor shall be designed in accordance with NFPA 654.

14. Each discharge on each screw conveyor shall be provided with an automatic slide gate with pneumatic actuator. Flanged drip-less slide gates shall be provided for the screw conveyor discharge openings.

15. The gate blade shall be supported on 1 1/4 inch stainless steel rollers, which are located out of the material flow. The rollers will include bronze bushings, which require no lubrication. The gate blade leading edge shall be beveled to facilitate its travel through the material being handled. The gate shall be provided with a ramping mechanism to help force the gate blade against the seal. The retract frame shall incorporate expanded metal guards for safety purposes.

16. Gate wiping seals shall be made of UHMW polyethylene. The seals shall contact the top of the gate blade along the perimeter of the throat opening. The seals shall be retained by a bolted steel bar which forms the inlet throat lining of the slide gate.

17. The automatic slide gate pneumatic actuators shall be single acting-spring return air cylinder actuators with air sets, exhaust mufflers, speed control valves, pilot solenoid valves and limit switches. The actuator shall be provided by automatic slide gate manufacturer and shall be factory mounted.

    a. Cylinder type actuators shall consist of a heavy-duty, front head-mounted single acting-spring return pneumatic cylinder, constructed to ANSI specified dimensions for interchangeability. Each cylinder shall include hard, chrome-plated rod; long-wearing, double seal configuration; and a heavy steel cylinder tube. Each cylinder shall be clevis mounted to the slide gate blade.

b. Cylinder type actuators shall provide satisfactory operation with dry, oil free instrument air at 80 psig pressure and shall be shop tested at 240 psig. The valve actuator mechanism coupled to the cylinder shall be totally enclosed. The cylinder shall be rigidly secured to the mechanism housing and shall not pivot, rotate, or swing during operation. The cylinder piston rod shall be enclosed in the mechanism housing and shall not be exposed to view.
c. The actuator shall be configured such that on power failure, the spring shall drive the valve closed. Each actuator shall be furnished with a 3 way solenoid valve suitable for use in a NEC Class II, Division 2, Group G area. A flow control valve shall be furnished and installed in the solenoid valve vent.
d. Air piping, isolation, and two-way diversion solenoid valves shall be pre-mounted on the gate. Valves shall be provided in air lines to allow for speed adjustment for opening the slide gate. Air shall be supplied from the plant compressed air supply. Solenoid valves shall be single coil rated 120 volt ac and shall be energized to open the gate.
e. Each gate shall include one pair of limit switches, spdt, 316 stainless steel NEMA Type 4X enclosure suitable for use in a NEC Class II, Division 2, Group G area, mounted to the gate retract frame to provide remote Open/Close position indication. System Supplier shall provide all supports for the actuator. Supports shall resist all loads imposed by the actuator, including thrust during operation.

18. Each telescoping chute shall have a dust collection discharge connection with a pneumatic operated butterfly valve. The pneumatic operated butterfly valve and shall be constructed of the following materials.

a. Body/Disc: ASTM A 351, CF8M, 316 stainless steel
b. Rating: Class 150
c. Seat: RTFE
d. Stem 17-4 Stainless steel
e. Stem Packing: TFE or PTFE
f. Shaft Bearings: Graphite impregnated or PTFE impregnated 316 stainless steel
g. End connection: Lugged wafer, ASME B16.5, Class 150 diameter and drilling
h. Manufacturer: Keystone K-LOK High Performance Figure 362-159; Pratt Series 400, Figure 402

19. The dust control butterfly valve pneumatic actuator shall be single acting-spring return pneumatic vane type actuator with exhaust muffler and speed control valve.

a. Actuator shaft and vane shall be a single machined part. Vane lip seals shall be constructed by the dual opposed injection molded method. Stainless steel expanders shall be fitted beneath the vane lip seals to ensure continual seal-to-case contact. All actuators shall be fitted with stainless steel threaded travel stops allowing adjustment at each end of actuator stroke.
b. Vane type actuators shall be sized to provide a safety factor of 25% for open-close service, shall be designed to provide satisfactory operation using dry, oil free instrument air at a minimum 80 psig pressure (or as designed by the System Supplier's compressed air system), and shall be shop tested at 225 psig. Pneumatic vane type actuators shall be as manufactured by Kinetrol, Ltd. or K-Tork International, without exception.

c. Vane actuators shall be configured such that on power failure, the spring shall drive the valve open or closed determined by the Dryer System Supplier based on the functional requirements of the system. Springs shall be clock type. Each actuator shall be furnished with a 3 way solenoid valve suitable for use in a NEC Class II, Division 2, Group G area. A flow control valve shall be furnished and installed in the solenoid valve vent.

d. Actuator manufacturers shall have 5 years experience with the spring return model to be provided and shall furnish references with contact information on request. Each actuator shall be factory assembled with piping and all required accessories including solenoid valve, positioner, flow control valves, and other accessories required for a properly operating system.

20. Each discharge from the screw conveyor shall include a motorized chute which acts as flexible extension at the discharge. Each chute shall be designed to minimize emissions of fugitive dust particles during material discharge. Each chute shall be constructed of conical AR 240 steel sections suspended on stainless steel rope and surrounded by a vinyl polyester sleeve. The product shall flow through inner chute, while dust created during unloading is captured from the annular section between the outer sleeve and inner chute. Captured dust shall be directed to the dust collection wet scrubber. A damper that closes and opens at the beginning and end of load-out operations shall be provided. Extension and retraction of each chute shall be controlled through a triple cable hoisting system powered by an electric motor.

    a. The System Supplier shall provide both an automatic and manual mode of operation as part of their control strategies. The motorized chutes shall have the capability to automatically sequence when in an automatic operation mode, or controlled manually when in a manual operation mode.

21. Conveyor manufacture shall provide safety equipment and safety guards as required by OSHA and as indicated in ASME B20-1, Safety Standards for Conveyor and Related Equipment.

22. System shall be provided with a local control panel.

23. Provide local pendent controller that is accessible via the truck load out area and provides the ability to start, stop, lower and lift each of the telescoping chutes without needing to use the local control panel or PLC.

    The System Supplier shall design the pendent controller so that it is located out of the truck traffic path to prevent damage to the instrument.

C. Materials of Construction

1. The trough and cover for shafted screw conveyors shall be constructed of Type 304L stainless steel. The flights for shafted screw conveyors shall be constructed of ASTM A514 steel with a minimum Brinell hardness of 235.

2. Trough inlet and outlet connections shall be fabricated from a minimum 1/4 inch Type 304L stainless steel plate.

3. Conveyor covers and hinges shall be constructed of stainless steel.

4. Slide Gate: Gate surfaces in contact with the conveyed material shall be constructed of minimum 1/4 inch thick Type 304 stainless steel. All other surfaces shall be constructed of 1/4 inch thick, Type 316 stainless steel materials.

    a. The gate blade shall be constructed of Type 304L stainless steel. All welding shall be per AWS standards.
    b. The gate blade shall be supported on 1 1/4 inch stainless steel rollers, which are located out of the material flow. The rollers will include bronze bushings, which require no lubrication.

5. Transfer chute: conical AR 240 steel sections suspended on stainless steel rope and surrounded by a vinyl polyester sleeve.

D. Controls

1. Controls shall be supplied in accordance with Section 11000.

2. Each load out conveyor shall be provided with the following instrumentation to send a signal back to the dryer control system for monitoring and system control:

    a. Motor operating status.
    b. Motor high temperature switch integral with motor.
    c. Zero speed switch located at the opposite conveyor end from the drive.
    d. Plug detection based on power/current draw, which will shut off power to the conveyor and sound an alarm.
    e. For variable speed screw conveyors, speed indication.
    f. Automatic slide gate position (each slide gate individually).
    g. Load out chute operating status (each chute individually).
    h. Load out chute position (each chute individually).
    i. Emergency stop push button for loadout.

3. A local load out control panel shall be provided for the dried solids load out conveyor. Provide panel components and fabrication requirements as specified in Section 11000.

E. Motors

1. Motor: Shall be in accordance with Section 16220 Low Voltage Motors and as specified herein. Motors shall be listed for installation in a NEC Class II, Division 2, Group G area and a NEC T Code of T3.. Where operated from a variable frequency drive the motor shall be inverter duty rated per NEMA MG-1.

F. Spare Parts: One of each size and type of bearings.

2.12 DRYER OFF-GAS CONDENSER AND FAN

A. General - <52-ME-01-DOG> - Provide one (1) condenser and off-gas system. System will include one spray duct, spray tower condenser, fixed venturi, separator tank, and exhaust fan (52-F-01-FA).

B. Performance Requirements

1. Provide one stainless steel spray duct to transport the dryer exhaust gases to the spray tower condenser. The spray duct shall have a minimum of three (3) non-

clogging type spray nozzles to continuously flush the duct. All nozzles shall be easily maintainable and replaceable from the exterior of the duct. All connections shall be provided with an isolation ball valve and a pressure gauge.

2. Provide a single-stage barometric condenser/cooler with cylindrical construction and with dished head top and bottom construction. Vapor contact parts shall be Type 304L stainless steel and shall be rated for full vacuum, and 14.7 psig. The condenser shall be free standing and supported to grade with carbon steel support legs.

3. The condenser shall have inlet and outlet vapor flanged connections, bottom drain flange, flanged instrument connections. Provide multiple water-spray headers, with self-cleaning spray nozzles, on the straight side of the condenser.

4. Provide one centrifugal fan rated for a maximum of 300 scfm and head as required to convey off gases from dryer through the existing fan discharge pipe and into the existing outdoor biofilter. Fan motor shall be inverter rated duty suitable for use with a variable frequency drive provided by others. Fan motor shall be inverter rated duty suitable for use with a variable frequency drive located in the Dryer System Supplier furnished MCC and as specified in Section 16442.

   The fan will discharge into the discharge duct of the existing fan (14-F-12-FA) that conveys foul air to the existing biofilter.

   The fan discharge piping and valve sizing shown on the Drawings is based on the maximum flowrate indicated above. The Dryer System Supplier is responsible for confirming and coordinating the piping and valve sizing required based on their actual fan design capacity.

   Dryer System Supplier shall design the fan taking into consideration the general foul air pipe routing, pipe and valving types and size, and the discharge pressure of 9” w.c. in the 36-inch ductwork that is currently conveying foul air to the existing biofilter.

5. Drawings show fan mounted to the separator tank to conserve space; however, fan may be floor mounted provides access clearances are maintained. Changes to the design shall be coordinated by the Contractor with the System Supplier.

6. Fan inlet shall be provided with a temperature gauge and pressure gauge. Fan discharge shall be provided with a check valve and a pressure gauge.

7. Fan discharge check valve shall be sized by the Dryer System Supplier so it will not flutter during normal flow. The check calve shall be class 150 dual disc wafer type. The body, disc, hinge pins/stops, and springs shall be A351-CF8M, 316 Stainless steel. The seat and bushings shall be TFE, the end connections shall be plain, installed between ASME B16.5, Class 150 diameter and drilling. The check valve shall operate from -20 to 212°F and be Mueller Steam Specialty, “Model 72”, Apco “Series 9000”, or Val-Matic.

8. Fixed venturi scrubber shall be provided to remove additional particulates from the dryer off-gas process stream prior to being discharged into the existing foul air duct system. The venturi shall be sized for a minimum of 5” w.c.

9. Separator tank shall be provided to receive and collect particulate laden water from condenser and venturi.

10. Off-gas condenser supports and anchorage shall be designed by the Dryer System Supplier.

11. Condenser drainage discharging from the condenser shall not exceed 120 deg F and the drain pipe shall include an above grade p-trap.

C. Materials of Construction

1. Spray duct: stainless steel

2. Condenser: vapor contact parts shall be Type 304L stainless steel. Support legs shall be carbon steel.

D. Controls

1. Controls shall be supplied in accordance with Section 11000 and as specified herein.

2. Each fan shall be provided with the following instrumentation to send a signal back to the dryer control system for monitoring and system control from the Dryer system PLC as specified herein and per Section 11000:

   a. Motor operating status.
   b. Fan speed indication
   c. Level switch high in separator tank as specified in Section 13433.
   d. Differential pressure across the entire venturi as specified in Section 13434.
   e. Temperature sensors and transmitters on dryer off-gas duct and fan discharge.
   f. Low flow switch on the utility water main line upstream of the connection to the condenser.

3. The following instrumentation shall be provided for local indication:

   a. Pressure gauges at connections of water lines to scrubber.
   b. Temperature gauge and pressure gauge on fan suction.
   c. Pressure gauge on fan discharge.
   d. Pressure gauges on water supply to condenser and fixed venturi.

E. Motor:

1. A variable speed motor shall be provided to drive the exhaust fan.

2. Shall be in accordance with Section 16220 Low Voltage Motors and as specified herein. Motors shall be listed for installation in a NEC Class II, Division 2, Group G area and a NEC T Code of T3. Where motor is operated under a variable frequency drive provide inverter duty rated motor per NEMA MG-1.

F. Spare Parts: One set of bearings.

2.13 DUST CONTROL SCRUBBER

A. General - <52-ME-01-FA> - Provide one (1) dust control scrubber. System will include a fan (52-F-02-FA) designed to conveyor dust from the dried solids load out chutes and other locations where dust control is necessary. Treated foul air will be vented to atmosphere in location shown on the Drawings.

B. Performance Requirements

1. A wet venturi scrubber shall be furnished to remove particulate from aspiration air from the load out chutes and, if required by the System Supplier's system, from the dried solids material handling system.

2. The wet venturi scrubber shall be dual throat designed to remove particulate matter from the process gas stream. Water introduced in the dual throat section shall be atomized to facilitate capture of particulate in water droplets, which shall largely be removed in the scrubber sump area as the process gas changes direction. The dual throat shall be manually adjustable to allow adjustment if system flows change. The scrubber shall be provided with a chevron-type eliminator to remove excess water from the process gas stream. The minimum efficiency of the scrubber/condenser shall be a 95 percent by weight removal of particulates sized at 5 micron (micrometers) or larger.

3. The scrubber shall be a vertical flow unit where the process gas stream enters at the top of the unit and exits from the top of the unit. The scrubber shell shall be constructed of Type 316L stainless steel with a minimum thickness of 1/8 inch. The scrubber shall be designed for the maximum vacuum condition, which the scrubber fan will be able to produce at zero gas flow. The scrubber inlet and outlet flanges shall be constructed of all welded, Type 316L stainless steel. The scrubber water inlet connections and piping shall be constructed of Type 316L stainless steel. The scrubber housing shall be reinforced with external Type 316L stainless steel stiffener angles or plates as required to prevent permanent deformation when subjected to the maximum design vacuum pressure. Support legs for each scrubber shall be carbon steel structural shapes with baseplates suitable for bolting to concrete bases or floors.

4. The scrubber shall be furnished complete with all internal and external interconnecting water piping between spray connections. The scrubber shall be suitable for use with plant utility water for the water supply. The scrubber shall be provided with a valve to adjust the water flow. This valve shall be furnished with a vane type pneumatic actuator which shall conform to the requirements indicated for vane type actuators in this specification.

5. The scrubber shall be provided with a p-trap at the bottom of the unit, of sufficient length to ensure a water seal under all operating conditions. The lowest point of each p-trap shall be provided with a cleanout. The scrubber shall be equipped with two 24 inch by 16 inch hinged access doors, one located above the sump section and one located at the mist eliminator area to allow access during repair or maintenance of the unit. Access doors and inlet and outlet ductwork connections shall be bolted and gasketed in a manner suitable for the design pressure and temperature of the scrubber.

6. The scrubber condenser shall be provided with a chevron-type mist eliminator, constructed of high-density polyethylene.

7. The fugitive dust system fan shall be a radial or backward inclined, VFD direct drive unit constructed of stainless steel. Each fan shall be provided with plugged one inch drain and shaft seals. The fan wheel shall be of all welded construction and shall be statically balanced.

8. A silencer shall be provided in the foul air duct as indicated on the drawing. The silencer shall be straight-through annular absorption type with packing suitable for continuous operation at 150 F. The silencer shall be of all-welded Type 316L stainless steel construction and flanged connections with diameter and drilling conforming to ANSI B16.1, Class 125. The silencer shall be as manufacture red by Burgess-Manning, Universal Silencer, Maxim, or equal. The silencer shall be suitable for 2,500 ACFM air flow, 100 F temperature with no more than 0.5 inches water column pressure drop across the unit. The minimum silencer sound attenuation for each octave band shall be as follows:

Octave Band	Attenuation, dB
63	5
125	10
250	16
500	20
1,000	25
2,000	25
4,000	20
8,000	13

C. Materials of Construction

1. Scrubber housing, flanges, and external reinforcement: Type 316L stainless steel

2. Mist eliminator: High-density polyethylene

D. Controls

1. Controls shall be supplied in accordance with Section 11000 and as specified herein.

2. The scrubber shall be provided with the following instrumentation to send a signal back to the dryer control system for monitoring and system control:

   a. Low pressure switch monitoring scrubber water supply per Section 13434.
   b. Level switch to indicate plugged drain condition per Section 13433.
   c. Differential pressure across the entire scrubber per Section 13434.
   d. Dust scrubber fan motor operating status.
   e. Fan speed indication.
   f. Scrubber supply water low flow switch per Section 13432.

3. In addition to the instrumentation specified above, the scrubber shall be provided with the following instrumentation to provide local indication:

   a. Pressure gauge and flow indicator at the connection of water supply to the scrubber. Location shall be provided so that the readings are accessible from the ground.
   b. Flow meter of the rotometer type for water supply to the scrubber.

c. Differential pressure across the mist eliminator. Location shall be provided so that the readings are accessible from the ground.
d. Differential pressure across the entire scrubber. Location shall be provided so that the readings are accessible from the ground.

E. Motor:

1. A variable speed motor shall be provided to drive the dust control scrubber fan.

2. Shall be in accordance with Section 16220 Low Voltage Motors and as specified herein. Motors shall be listed for installation in a NEC Class II, Division 2, Group G area and a NEC T Code of T3. Where operated under a variable frequency drive provide inverter duty rated motor per NEMA MG-1.

F. Spare Parts: One set of fan bearings.

2.14 DUST COLLECTION DUCTWORK

A. General – Dust collection ductwork shall be provided between the truck loadout chutes and the dust control scrubber.

B. Performance Requirements

1. Ductwork for the dryer fugitive dust system shall be constructed of Type 304L stainless steel. Straight ductwork with diameters 6 inches or less shall have a minimum thickness of 16 gauge, and straight ductwork with diameters greater than 6 inches shall have a minimum thickness of 14 gauge. Ductwork flange connections shall have a minimum thickness of 1/4 inch. Ductwork shall be sized for a minimum duct velocity of 4,000 feet per minute. Ducts shall be designed to keep the ductwork clean and free of residual material. Duct curves, bends, offsets, transitions and transformation pieces shall be gradual, to minimize air turbulence. Changes in duct size shall have a taper of less than 30 degrees to prevent the accumulation of material. A means of disassembling the ductwork shall be provided every 25 feet to assist in cleaning plugged ductwork.

2. Elbows and fittings shall be a minimum of 2 gauges heavier than straight duct.

3. Flat back (shielded) elbows with replaceable, abrasion resistant "Ultra High Molecular Weight UHMW Polyethylene" heels and flanged connection. For duct 3-inches through 8-inches in diameter, elbow turning radius shall be equal to 2-1/2 times the duct diameter.

4. Hangers and supports shall be sized for 1-1/2 x duct weight plus duct half full of conveyed material. Construct and located hangers per SMACNA standards.

2.15 ROTARY VALVES

A. General - <52-V-11-DRSR, 52-V-11-DRS> - Provide rotary valves as required by the System Supplier’s design.

B. Performance Requirements

1. Rotary valves shall be sized appropriately for maximum solids throughput. Rotary valves shall be sized so that the maximum operating speed does not exceed 27 rpm with a 33 percent volumetric loading.

2. All rotary valve bodies and end plates shall be constructed of cast iron with 0.10 inch thickness. All rotor shafts shall be sealed with packed gland stuffing box arrangement. All rotors shall be fabricated from carbon steel with replaceable, adjustable Type 304 stainless steel rotor tips.

3. Geared motors shall be hollow shaft, direct coupled with a mechanical service factor of 1.5 based on a minimum connected power of 1.5 horsepower.

4. Each rotary valve shall be designed in accordance with NFPA 69 to provide deflagration control by passive isolation and 654 to provide isolation of equipment.

C. Materials of Construction

1. Rotary valve bodies: cast iron

2. Rotors: carbon steel with Type 304 stainless steel rotor tips

D. Controls

1. Controls shall be supplied in accordance with Section 11000 and as specified herein.

2. Each rotary valve shall be provided with the following instrumentation to send a signal back to the dryer control system for monitoring and system control:

   a. Zero speed switch.
   b. Motor operating status.
   c. Motor high temperature switch integral with motor

E. Motor:

1. A variable speed motor shall be provided to each rotary valve.

2. Shall be in accordance with Section 16220 Low Voltage Motors and as specified herein. Motors shall be listed for installation in a NEC Class II, Division 2, Group G area and a NEC T Code of T3. Where motor is operated under a variable frequency drive provide inverter duty rated motor per NEMA MG-1.

F. Spare Parts:

1. One set of bearings.

2. One set of rotor tips.

2.16 COMPRESSED AIR SYSTEM

A. General - The drying unit shall be provided with a compressed air system to provide compressed air for all pneumatic, process and instrumentation requirements of the drying system. The compressed air system shall consist of duty/standby rotary screw compressors, receiver, desiccant dryer, air filters, and control system.

B. Performance Requirements

1. Each rotary screw air compressors shall be capable of producing the flow and pressure required for the dryer system, with a minimum safety factor of 1.5 for flow capacity at the rated pressure. Each air compressor shall be self-contained and include a complete control package. Each unit shall be capable of remote start and stop. The rotary screw air compressor shall be as manufactured by Kaeser, Atlas Copco, or equal.

2. Each compressor and all its accessories and appurtenances shall be completely enclosed within an acoustic enclosure. Each compressed air module shall include an dry type intake filter, compressor with integral air-cooled aftercooler, moisture separator with automatic operated condensate drain, motor, air/oil separator reservoir, oil cooler, separator pressure relief valve, discharge check valve, moisture separator with automatic drip trap, controls, control panel, enclosure, base, valves, piping, and unloading system. Each skid shall have a maximum discharge temperature of 120 F. Each air compressor module components shall be standard products of the manufacturer. Each module shall be completely factory assembled requiring only field connection of electrical power and air, and condensate drain piping. Each compressor air skid shall mount to a concrete base, as shown on the Drawings.

3. Each compressor shall be of the single stage, positive displacement, oil-flooded, rotary screw type. Compressor rotor shall be steel or high strength ductile iron with integral shafts, and dynamically balanced. Housing shall be cast iron. Rotors and housing shall be precision machined for accurate bearing positioning and running clearances. Radial bearings shall be cylindrical roller type. Thrust bearings shall be in accordance with the manufacturer's recommendations. Bearings shall have a minimum ABMA L_{10} life rating of 90,000 hours.

4. Positive pressure lubrication shall be provided either by a positive displacement, gear type full capacity oil pump, or by an inherent pressure differential system. A synthetic lubricant designed to limit foaming and lubricant carryover shall be provided as recommended by the manufacturer. A lubricant filter shall be provided with a 10 micron absolute rating.

5. The air/oil separator reservoir shall be designed and constructed in accordance with the ASME Code for Unfired Pressure Vessels. Oil carryover downstream of the compressor module shall not exceed 3 ppm by weight.

6. Each compressed air filters shall be of the coalescing type oil-removal type and shall be furnished with an automatic condensate drain.

7. A receiver shall be provided with the air compressor. The receiver shall be a vertical tank of all welded construction with semi-ellipsoidal heads and leg supports for mounting on a concrete base. The receiver shall be designed and constructed in accordance with the ASME Code for Unfired Pressure Vessels and shall bear the code stamp for a design pressure of 200 psig. The receiver shall have sufficient capacity to maintain design pressure in the compressed air system without excessive cycling of the air compressor in excess of the manufacturer’s recommended operation. The receiver shall be provided with an inlet, outlet, and drain, ASME safety relief valve, receiver vent with globe valve, pressure gauge, cleanout opening, and automatic condensate drain.

8. An air dryer shall be furnished for the compressed air system and shall be a dual tower, heatless regenerative type capable of producing a -40 F pressure dewpoint. The dryer shall be completely factory assembled, piped and wired. The dryer shall be furnished with standard tower and inlet header pressure gauges, purge exhaust silencers, adjustable purge flow rate valve, color change moisture indicator, and tower relief valves. Dryer cycle timer shall be field adjustable from 4 minutes to 10 minutes. The dryer shall be furnished with duty/standby prefilters to protect the desiccant beds from oil and/or free water contamination and duty/standby afterfilters to prevent desiccant carryover. Each dryer shall be rated for an inlet temperature of 120 F.

C. Controls

1. Each compressed air system shall be provided with the following instrumentation to send a signal back to the dryer control system for monitoring and system control:

   a. Air compressor operating status.
   b. Air compressor general alarm condition.
   c. Receiver low pressure switch per Section 13434.
   d. Desiccant Dryer operating status.
   e. Desiccant Dryer general alarm condition.

2. The compressor control system shall automatically start, stop, load, unload, and control capacity to provide constant downstream air pressure within preset limits determined by the System Supplier.

3. Capacity control shall be by cycling. After the compressor has operated for an adjustable time while unloaded, it shall automatically stop. The continuous run timer adjustment range shall be 0 to 60 minutes, with an initial setting of 15 minutes. The capacity control system shall be designed to prevent oil foaming and carry-over with a minimum system cycle time of 10 seconds.

4. The local control panel shall indicate the following minimum conditions:

   a. Elapsed time of operation in hours, non-resettable.
   b. Delivered air pressure.
   c. Inlet air filter service required based on pressure differential switch.
   d. Lubricant filter service required.
   e. Air/oil separator filter service required.
   f. Compressor running/ auto
   g. Other compressor alarms as recommended by the manufacturer.

5. The local control panel shall stop the compressor, alarm the condition and indicate the alarm with a light and an audible alarm at the local control panel; and shall indicate the alarm on the control panel for each of the conditions below. The controls for these items shall be integral to each compressor.

   a. Low oil level and/or pressure.
   b. High discharge air temperature.
   c. Lubrication or cooling system issues/problems.
   d. Motor overload.
   e. Discharge air pressure low, based on the pressure transmitter or pressure switche.

6. A common "Reset" shall be provided so the alarm indicators are displayed until manually reset. Controls shall be designed to allow testing of the alarm indicators without actuating the remote alarm.

7. In addition to the controls above, the following local indication shall be provided for the compressed air system:

   a. Differential pressure across the pre-filter and after filters.
   b. Pressure gauge for air receiver.
   c. Local temperature indicator (integral to compressor) on each compressor discharge.

2.17 ACCESS.

A. General

1. Proper access shall be provided to all portions of the dryer system that require operation, maintenance and repair. Access provisions shall meet the requirements of OSHA, the latest edition of the California Building Code with Local Amendments, and other applicable codes and regulations as a minimum. All access shall be convenient and provide unobstructed access to all areas of mechanical equipment, equipment drives, bearings, hatches, lubrication points, inspection doors, access doors, sample ports, valves, mist eliminators, electrical equipment, controls, and instrumentation.

2. As a minimum all access pathways shall be at least 3 feet clear unobstructed width (unless otherwise noted on the Drawings) and at least 7 feet 6 inches in clear unobstructed height. There shall be no tripping hazards. There shall be a minimum of three feet clear and unobstructed pathway around all equipment for safe and convenient access, except for sides of equipment which do not require access and for which meeting this requirement would negatively impact the operation and layout. Access to any particular equipment shall be increased to 1.25 times the largest dimension of the largest part of that particular equipment that may require removal and replacement.

3. Locations adjacent to dryer system equipment that exceeds the exterior temperature indicated in Paragraph 2.1.H.1 Performance Requirements or to other dangerous equipment that are within 7-feet of the floor or working platform or within 15-inches horizontally from stairways, ramps, or fixed ladders, shall be guarded with a standard railing and toe board, gates, or with similar protection measures that conforms to OSHA requirements and other applicable codes and regulations. Warning/Caution signs shall be provided for these locations.

B. Platforms, Walkways, and Stairways

1. Platforms, walkways, stairways, and ladders are deferred submittal items and are the responsibility of the Dryer System Supplier. Deferred submittal items shall be stamped and signed by a Civil or Structural Engineer registered in the State of California.

2. Access provisions consisting of access platforms, catwalks, ladders, handrails, stairways, and other necessary items as required by OSHA, ANSI A117.1, the 2016 California Building Code with Local Amendments, and other applicable codes and regulations shall be provided for the drying unit. Access to major

equipment platforms shall be by stairs when practical. Use of ladders for access shall be subject to the approval of the authority having jurisdiction and/or the Owner.

3. Structural framing for access platforms, walkways, ladders, and stairways shall be of structural steel construction and shall be in accordance with Section 05120. Grating for platforms and stairways shall be of aluminum construction in accordance with Section 05510 Grating. Checkered plate for platforms shall be of aluminum construction in accordance with Section 05500 shall be protective coated as specified in Paragraph 1.06.

4. All elevated access areas shall be protected with guardrails in accordance with the local building code, ANSI A117.1 and OSHA. Handrail and guardrail shall be constructed of round aluminum pipe in accordance with Section 05520 Handrailing, Guardrailing, and Ladders.

5. In addition to where specified elsewhere in this section, access platforms shall be provided at a minimum for the following equipment items:

   a. Front side of dryer
   b. Screener
   c. Dryer off gas condenser

PART 3 EXECUTION

3.1 DELIVERY AND STORAGE

A. A complete set of Dryer System Supplier's instructions covering storage, installation, operation, lubrication, and maintenance shall be furnished to the OWNER no later than the date the equipment is shipped. Care during storage and procedures for installation, lubrication, and startup of the equipment and motors shall be in strict conformance with the Dryer System Supplier's instructions.

3.2 INSTALLATION

A. Install in accordance with the MANUFACTURER's printed instructions and in accordance with requirements of NFPA 68, NFPA 69, NFPA 87, and NFPA 654.

3.3 TESTING

A. General – The System Supplier shall perform testing in accordance with Section 01660 Testing and Training, Section 11000 Equipment General Provisions, Section 16080 Electrical System Analyses and Commission Field Testing, and 16960 Electrical System Analyses and Commission Field Testing, and as specified herein.

B. Factory Testing – Perform Factory testing in accordance with Section 01660 Testing and Training, section 11000 Equipment General Provisions, Section 16442 Motor Control Centers, and 16960 Electrical System Analyses and Commission Field Testing on the following items:

   1. Motors 100 hp and larger

   2. Dewatered sludge hopper live bottom screw conveyors

3. Dewatered sludge pumps

4. Paddle dryer

5. Thermal fluid heater

6. Screw conveyors

7. Dried solids screen

8. Drag chain conveyor

9. Dryer off-gas condenser and fan

10. Dust control scrubber

C. Functional Testing – Perform Functional Testing in accordance with 01660 Testing and Training and 11000 Equipment General Provisions.

D. Operational Testing – Perform Operational Testing in accordance with 01660 Testing and Training.

E. Performance Testing – Perform Performance Testing in accordance with 01660 Testing and Training and 11000 Equipment General Provisions.

F. Performance Requirements Testing

1. Following completion of the Performance Testing, perform Performance Requirements Testing as specified herein. Performance Requirements Testing shall demonstrate compliance with the specified performance requirements for evaporation rate, solids processing rate, dried product dried solids percentage, dried product cooled temperature, maximum fuel usage, maximum electricity usage, Class A compliance, and dried product size.

2. The City will provide operations personnel, power, fuel, chemicals and other consumables for the Performance Requirements Testing.

3. The Startup Team shall jointly develop the plan for the Performance Requirements Testing at least 90 days before testing is scheduled. The System Supplier shall have responsibility for development of the plan. The City will provide and designate other members of the Startup Team from the Design Consultant and Operations Staff.

4. The System Supplier shall submit a detailed Performance Requirements Testing Plan. The testing plan shall include the following:

   a. Performance requirements testing requirements
   b. Test prerequisites
   c. Pre-test activities
   d. Testing procedures, including sample locations
   e. How data will be analyzed, including equations
   f. Personnel and testing responsibilities
   g. Quality control procedures

5. The testing protocol shall be reviewed for conformance before Performance Requirements Testing can start.

6. The dewatered sludge will be in a cake form with solids content as provided by the belt filter press performance during testing. The System Supplier shall coordinate with the Owner the sludge processing rate to account for variations in the cake solids concentration.

7. The ability of the dryer system to achieve the Performance Requirements shall be determined by the results obtained during the Performance Requirements Testing. The Performance Requirements Testing results shall be evaluated by the Owner.

8. During the Performance Requirements Testing, the System Supplier shall provide equipment to take and analyze samples. The Performance Requirements Testing shall be the responsibility of the System Supplier, and completed at the System Supplier's expense. The Owner shall be granted access to witness the Performance Requirements Testing at all times.

9. Performance Requirements Testing. One test run with a duration of 8 hours running on sludge will constitute the Performance Requirements Testing. If the dryer unit shall stop for more than a period of 30 minutes during the Performance Requirements Testing shall be terminated and the testing rescheduled. All data collected during the Performance Requirements Testing shall be used in analyzing the test results. The average values determined from the entire 8 hour period shall be used in analyzing the test results. All instruments used for recording test data shall be calibrated prior to testing. Calibration certificates shall be available for review during testing, and shall be included in the test report. All costs associated with testing, including sampling and analysis shall be the responsibility of the System Supplier.

10. Assumptions. The following assumptions apply to the Performance Test:

    a. Shutdowns caused by parties other than System Supplier, its subcontractors, vendors or agents will not count against test downtime requirements.
    b. Shutdowns or poor test results caused by sludge not in accordance with the parameters set forth in Paragraph 2.1 will not count against test downtime or performance results.
    c. Owner will be responsible for handling and disposal of all biosolids.

11. Test Procedures for Solids and Evaporation Capacity. Dewatered sludge samples shall be taken once every two hours to determine average cake percent solids feed to the dryer during the testing. Average final product percent solids shall be determined from samples taken once every two hours at the discharge of the dried solids load out conveyor. The amount of solids dried shall be demonstrated by weighing the product with a truck scale. System Supplier shall construct a drying system mass balance to the satisfaction of the Owner in the determination of performance compliance for solids and evaporation. Any allowances for solids losses at the screen, condenser liquid discharge, or process gas exhaust shall be supported by test data taken during the test. At the start of the test, product produced by the dryer will be conveyed to an empty truck (test truck). During the test, all the material sent to the test truck shall be weighed. Solids content of dewatered cake and product shall be analyzed based on the current edition of Standard Methods for Examination of Water and Wastewater.

12. Test Procedure for Product Quality. Samples shall be taken at the discharge of the dried solids load out conveyor once every two hours. For solids content, each sample shall be analyzed and then the average results of all samples used to determine whether requirements have been met, except that each sample shall demonstrate compliance with Class A product requirements. For product size distribution, a composite sample shall be made for the samples from the overall performance test and analyzed to determine whether requirements have been met. For confirmation that the requirements of a Class A product are met, the appropriate parameters as defined by 503 EPA regulations shall be monitored. Product solids content shall be analyzed based on the current edition of Standard Methods for Examination of Water and Wastewater. Product size distribution shall be determined by a sieve analysis utilizing a roto-shaker and mesh screens.

13. Test Procedure for Specific Heat Energy. The total fuel used for the dryer shall be measured for the overall performance requirements test. Total fuel readings shall be taken at the start, each hour, and the end of each test. This data will be combined with the evaporation rate demonstrated by the mass balance developed as part of the solids and evaporation capacity analysis to generate the specific heat energy. The specific heat energy will be reported in units of BTU per pound of evaporated water.

14. Test Procedure for Electrical Energy Use. The MCCs delivering power to the drying unit will be equipped with a kilowatt-hour meter, with totalizer, supplied by System Supplier. Readings shall be taken at the start, each hour, and finish of the test to determine the total electrical energy used.

15. Cooled Product Discharge Temperature. The cooled product temperature shall be measured and recorded each hour at the discharge of the dried solids load out conveyor.

16. Performance Requirements Testing Report. Within 20 days after completion of the Performance Requirements Testing, the Performance Requirements Testing Report shall be submitted by System Supplier, with the following information:

    a. A general description of the testing, including the date and time of the performance requirements test for the dryer.
    b. A description of all samples collection and measurement techniques.
    c. Raw data collection sheets including operating data and original copies of all laboratory reports.
    d. Descriptions of operations problems, unusual conditions, equipment failures or malfunctions, and other factors adversely affecting performance of the Dryer System.
    e. Analysis of the test data, including sample equations.
    f. Performance test results in comparison with the Performance Requirements.
    g. Instrument Calibration Certificates.

17. Substantial Completion will not be issued until after successful completion of the Performance Requirements Testing and acceptance of the Performance Requirements Testing Report.

3.4 TRAINING

A. Training shall be provided for the process equipment, control, and electrical systems of the dryer system in accordance with Section 01660 Testing and Training and as

specified herein. In addition to the requirements of Section 01660 Testing and Training, training shall include “Initial Training” as specified in NFPA 68, NFPA 69, and NFPA 654 and “Training” as specified in NFPA 87 as applicable to the drying system. In addition to the requirements of Section 01660 Testing and Training, training shall cover inspection and maintenance requirements as described in NFPA 68, NFPA 69, NFPA 87, and NFPA 654 as applicable to the drying system.

END OF SECTION

SECTION 13111– CATHODIC PROTECTION

PART 1 GENERAL

1.1 SCOPE

A. The Contractor shall furnish all materials, install all equipment and provide all labor necessary to complete the work shown on the drawings and or/listed below and all other work and miscellaneous items not specifically mentioned but reasonably inferred, including all accessories and appurtenances required for a complete system. The intent of this specification is to provide for a complete, functional cathodic protection system for the Water Lines on the Waste Water Treatment Plant Expansion Project in Brentwood, CA.

1.2 WORK INCLUDED

A. Work included in this section consists of the components of the cathodic protection system, including magnesium anodes, cables, insulating joints, test stations and any other work necessary to complete the installation. A partial list of work included is as follows:

1. Cathodic protection of ductile iron pipe and fittings associated with the referenced Water Pipelines.

2. Cathodic protection of copper and ductile iron laterals.

3. Encasement of all ductile iron water main pipelines and fittings associated with the referenced Water Main Pipelines in polyethylene.

4. Tape wrapping of all copper and ductile iron laterals.

5. Bonding of non-welded pipe joints.

6. Trenching, drilling, and other excavation.

7. Installation of magnesium anodes, cables and test stations.

8. Backfill and compaction of backfill.

9. Electrical isolation of the new pipelines from existing pipelines and above grade structures utilizing insulating joints.

10. Electrical isolation of copper and ductile iron laterals from the water main and the water meters and building connections.

11. Provide shop drawings, reports, permits, and obtain Engineer's approval where required.

12. Correction of all deficiencies.

13. Cleanup and restoration of surface.

14. The work shall include the provision of all materials, equipment, and apparatus not specifically mentioned herein or noted on the plans, but which are obviously necessary to complete the work specified.

1.3 QUALITY ASSURANCE

A. GENERAL- All work shall be performed to the satisfaction of the Engineer.

B. MATERIALS - The Contractor shall not substitute for the specified materials unless approved by the Engineer.

C. TESTING - Electrical continuity of the pipelines, proper operation of anodes, test leads and all other cathodic protection components shall be tested by the Project Corrosion Engineer, in order to ensure proper installation and operation. The Contractor shall be responsible for correction of all deficiencies identified by the testing and all costs incurred for retesting prior to final acceptance.

D. COMPACTION - Compaction of backfill for anodes and trenches shall match the existing conditions and shall be approved by the Engineer.

1.4 REQUIREMENTS

A. Encase in polyethylene, as specified elsewhere, all buried metallic pipes, fittings and appurtenances associated with the water main pipelines.

B. Prime and tape wrap, as specified elsewhere, all buried metallic pipes, fittings and appurtenances associated with the water pipeline laterals between the main and the meters and from the meter to the limit of work.

C. Install galvanic cathodic protection on all buried metallic pipe, valves, fittings, risers, casings, laterals and appurtenances.

D. Install bond cables across all rubber gaskets, mechanical joints and flexible couplings, except insulating joints, along the entire buried length of contiguous, ductile iron pipe.

E. Install insulating joints to electrically isolate the subject pipelines from existing pipelines, water meters, water laterals, and above grade structures. Buried insulating joints shall be coated with a wax tape coating system.

F. Install test stations at all locations designated on the plans.

1.5 CODE REQUIREMENTS

A. All materials, workmanship, and installation shall conform to all requirements of the legally constituted authority having jurisdiction. These authorities include, but are not limited to, the latest revision of the State of California, Department of Industrial Relations, Division of Industrial Safety Orders of the Industrial Accident Commission, and all other applicable State, County, or City codes and regulations. Nothing in the drawings or specifications is to be construed to permit work not conforming to these regulations and codes. Where larger size or better grade materials than required by these regulations and codes are specified, the specifications and drawings shall have precedence.

1.6 REFERENCES

A. This section contains references to the following documents. They are a part of this section as specified and modified. In case of a conflict between the requirements of this section and those of the listed documents, the requirements of this section shall prevail.

1. National Association of Corrosion Engineers (NACE):

   a. SP-01-69 (2013) Standard Practice, Control of External Corrosion of Underground and Submerged Metallic Piping Systems.

   b. SP 0286-2007 Standard Practice, Electrical Isolation of Cathodically Protected Pipelines

2. American Water Works Association (AWWA): C105/A21.5-05 American National Standard for Polyethylene Encasement for Ductile-Iron Pipe Systems

3. American Society for Testing and Materials (ASTM):

   a. D-1248-84 Polyethylene Plastics, Molding and Extrusion Materials

   b. D-1557-78 Moisture Density Relations of Soils and Soil Aggregate Mixtures Using 10-lb. Rammer and 18-in. Drop

   c. C-94-81 Ready-mixed Concrete

4. Underwriter's Laboratories, Inc. (U.L.):

   a. 83-1983 Thermoplastic Insulated Wire
   b. 486A-1990 Wire Connectors And Soldering Lugs For Use With Copper Conductors

5. National Fire Protection Code (NFPA 70)

6. National Electrical Code (NEC)

7. National Electrical Manufacturers Association (NEMA):

   a. TC-2-1983 Electrical Plastic Tubing (EPT) and Conduit (EPC 40 and EPC PERFORMANCE

1.7 CONTRACTOR SUBMITTALS

A. Prior to commencing work, the Contractor shall submit for approval by the Engineer copies of the following items in accordance with submittal procedures:

A complete list of cathodic protection equipment and material, including name and manufacturer, catalog number, size, finish and any other pertinent data necessary for proper identification and to determine conformance with specifications.

1.8 INTERFERENCE AND EXACT LOCATIONS

A. The Contractor shall coordinate and properly relate this work to the site and to the work of all trades. The general locations of the facilities are shown on the drawings. However, the Contractor shall visit the premises and thoroughly familiarize himself with all details of the work and working conditions, verify existing conditions in the field, determine the exact locations of existing pipelines and structures and advise the Engineer of any discrepancy that may prevent or hinder the specified work from being completed. The Contractor shall be solely responsible for location and marking underground structures so as to avoid damage during construction.

B. The Contractor shall furnish all materials, install all equipment and provide all labor necessary to complete the work shown on the drawings and or/listed below and all other work and miscellaneous items not specifically mentioned but reasonably inferred, including all accessories and appurtenances required for a complete system. The intent of this specification is to provide for a complete, functional cathodic protection system for the Water Lines on the Waste Water Treatment Plant Expansion Project in Brentwood, CA.

PART 2 PRODUCTS

2.1 GENERAL

A. All materials shall conform to the requirements set forth herein or as designated on the drawings, unless otherwise specified. All materials must be new, free from defects, and shall be of the best commercial quality for the purpose specified. The Contractor shall furnish all necessary items and accessories not shown on the drawings or specified herein, but which are required to fully carry out the specified intent of the work, without additional cost to the Owner.

2.2 MAGNESIUM ANODES

A. Magnesium anodes shall be High Potential (Galvomag), Magnesium Alloy. Each anode shall be cast with a steel core, and the core shall protrude from one end and shall be of sufficient length to permit attachment of a lead wire.

B. Each anode shall conform to the following chemical composition:

Chemical Composition	
Aluminum	5.3 - 6.7% Max.
Zinc	2.5% - 3.5%
Manganese	0.15% - 0.7%
Silicon	0.10% Max.
Copper	0.02% Max.
Nickel	0.002% Max.
Iron	0.003% Max.
Other Impurities	0.30% Max.
Magnesium	Balance

C. Each anode shall be furnished with a lead wire attached to one end of the steel core, and the wire shall be of sufficient length to attach to the test station as shown on the drawings. The wire shall be connected to the steel core by silver soldering, and the connection shall be mechanically secured before soldering. The entire connection shall

be insulated with an electrical potting compound. The cable attached to the anode shall be No. 10 AWG, Type THHN stranded, single conductor copper.

D. The anode shall be prepackaged in a permeable cloth bag filled with a mixture of 75% ground hydrated gypsum, 20% powdered bentonite, and 5% anhydrous sodium sulfate. Backfill shall have a grain size so that 100% is capable of passing through a 100-mesh screen. The mixture shall be firmly packed around the anode within the cloth bag by means of adequate vibration so that the magnesium ingot is completely surrounded with a minimum 1 in. of backfill material.

2.3 CABLES

A. Cables used for joint bonding shall be single conductor, stranded copper, Type THHN CP, insulated for 600 volts with High Molecular Weight Polyethylene (HMWPE) in accordance with the requirements of ASTM D 1248, Type 1, Class C, Grade 5.

B. All cables for anodes and test stations shall be Type THHN, stranded, copper, sized as shown on the drawings and shall conform to Federal Specification JC 30B.

C. Insulation Color

1. Project Pipe: White

2. Existing Pipe: Red

3. Anode or Anode Header Cable: Black

2.4 CABLE-TO-PIPE CONNECTIONS

A. Ductile Iron Pipe

1. All cable connections to the ductile iron force balanced expansion devices shall be accomplished by pin brazing. Pin brazing equipment based upon Electric-arc silver soldering using a specially designed portable Pin Brazing unit, a hollow brazing pin containing silver solder and flux shall be utilized for cable-to-structure connections. The unit may be battery powered or powered with a welding generator. Battery pack, pins with fuse wire, ceramic ferrules and cable lugs shall be in accordance with the manufacturer's recommendations for each wire size and pipe or fitting size and material. Brazing materials and equipment shall be the product of a single manufacturer. All material and equipment utilized for brazing shall be from one manufacturer.

a. BAC - GMC Electrical, Ontario, CA.
b. Farwest Corrosion Control, Hayward, CA.

B. Copper Pipe

1. All cable connections to copper pipe shall be accomplished utilizing a brass ground clamps.

2.5 CABLE-TO-PIPE COATING MATERIAL

A. Epoxy used for sealing the cable to pipe connection shall be one of the following:

1. Aquatapoxy® A-6, manufactured by Cohesant Materials;

2. ProPoxy® 20, manufactured by Hercules;

3. Durcon-164, manufactured by the Duriron Company;

4. Scotchcast Resin No. 4, manufactured by 3-M Company; or

5. CC-1 Potting Compound, manufactured by PSI Products.

2.6 TEST STATION

A. Ground level test stations shall be Christy G5 traffic box with 1.5-inch high iron grade ring per unit and a cast iron lid as shown on the drawing.

B. The cover shall be manufactured and engraved with the following markings for easy identification:

1. “CP-TEST"

2.7 TERMINAL BOXES

A. Type

1. Terminal boxes shall be locking type, constructed of high-impact, molded Lexan plastic.

B. Hardware

1. The test box shall be provided with sufficient hardware and terminal posts for each cable as shown on the drawings. All test station hardware, including nuts, bolts and shorting straps shall be nickel-plated brass. Terminal Boxes for the anode test stations shall be supplied with 6 amp, 0.01 ohm shunts from the same manufacturer as of the terminal box.

C. Cable Terminations

1. If terminal posts with washers and nuts are utilized, all cables that terminate in the terminal boxes shall have ring type connectors that are sized appropriately for the terminal bolts. The ring connectors shall be either a soldered ring type connection or a heavy duty, compression type crimp connection. With the compression type crimp connection a crimping tool shall be provided.

2. If binding post terminals are utilized, ring connectors are not required.

D. Color:

1. The terminal boxes for the water lines shall be orange in color.

E. Subject to Compliance with the Contract Documents the following Manufacturers are acceptable:

1. Model "Big Fink", Cott Manufacturing Company

2. Model T-3, Tinker & Rasor

3. Or equal.

2.8 CABLE WARNING TAPE

A. All buried test station and anode cables shall have plastic warning tape installed a minimum of 12 in. above the top of the cables for the entire buried length of the cables. The warning tape shall be 4 in. wide and shall be yellow with black lettering with the legend "CAUTION, CATHODIC PROTECTION CABLES BURIED BELOW" in 3 in. high lettering printed at a minimum of seven foot intervals along the entire buried length of the cable.

2.9 CABLE IDENTIFICATION TAGS

A. All cables in the terminal boxes shall be identified. The identification tags shall be white plastic "zip-tie" type straps with a plastic tab of sufficient size to allow the pipeline station to be written on the tab with a permanent felt tip marker.

2.10 INSULATING FLANGED JOINTS

A. The insulating flange kit shall be for water service, and suitable for wet and dry locations. Each insulating flange set shall consist of a full-face central gasket, a full-length sleeve for each flange bolt, and two insulating washers with two steel washers for each bolt. The full face central gasket shall be 1/8-inch thick sheet packing, having a dielectric constant of 300 volts per mil, minimum and shall be in compliance with NSF-61, such as Pyrox G-10, Quad-seal manufactured by Advance Products & System, Inc., Part number GET4PG10 or Gylon 3505 manufactured by Garlock Sealing Technologies or LineBacker 61™ sealing and isolating gasket by PSI. Bolt sleeves and insulating washers shall be Pyrox G-10. The complete assembly shall have an ANSI pressure rating equal to that of the flanges between which it is installed..

2.11 BURIED INSULATING JOINT COATING MATERIAL

A. Coatings for buried insulating flanges and insulating couplings shall consist of a non-conductive, petrolatum-based coating system, such as Trenton Wax Tape #1 by The Trenton Corporation, or equal. The coating system shall consist of a prime coat as an initial surface preparation to displace moisture on the surface and to improve adhesion of the wax tape. A wrap material shall be used to provide a smooth contour on the surface of the joint as well as for protection of the substrate. An over wrap shall be used as a final coating to provide increased mechanical strength of the coating. The prime coat shall be a petrolatum material with corrosion inhibitors and plasticizers. The wrap coat shall be a synthetic fabric saturated with a blend of petroleum wax, plasticizers and corrosion inhibitors. The over wrap shall be plasticized, self-adhesive PVC tape.

2.12 INSULATING UNIONS

A. Insulating unions, whether shown or not shown on drawings, shall be installed to isolate the two dissimilar metals. Insulating unions shall be installed at threaded or sweated fittings and shall have compatible ANSI pressure ratings.

B. The insulating union shall be “O-ring” Flat Faced Type 150 Class 300 CWP, as manufactured by Central Plastics Company, or approved equal.

2.13 BITUMASTIC COATING FOR FLANGE HARDWARE

A. Coating for all buried bolts, nuts and metallic washers shall be Bitumastic 300M, coal tar mastic coating, as manufactured by Carboline or approved equal.

2.14 TAPE WRAP FOR COPPER PIPE

A. All buried copper laterals shall be primed and tape coated with a minimum of 35 mil half-lapped pipeline tape. Primer shall be compatible with the tape wrap.

1. Polyken 930 Tape Coating or approved equal.

2. Polyken 1027 Liquid Adhesive System or approved equal.

2.15 POLYETHYLENE ENCASEMENT FOR DUCTILE IRON

A. The polyethylene sheets used for encasement of the ductile iron pipe and fittings shall be V-Bio polyethylene encasement, a minimum 8-mils thick low-density polyethylene in accordance with AWWA C-105/ANSI A21.5.

PART 3 EXECUTION

3.1 GENERAL REQUIREMENTS

A. All materials, workmanship and installation shall conform to all requirements of the legally constituted authority having jurisdiction. These authorities include, but are not limited to, the latest revision of the State of California, Department of Industrial Relations, Division of Industrial Safety, Electrical Orders; The National Electric Code, General Construction Safety Orders of the Industrial Accident Commission; and all other applicable State, County, or City codes and regulations. Nothing in the drawings or specifications is to be construed to permit work not conforming to these regulations and codes. Where larger size or better grade materials than required by these regulations and codes are specified, the specifications and drawings shall have precedence.

3.2 STORAGE OF MATERIALS

A. All materials and equipment to be used in construction shall be stored in such a manner to be protected from detrimental effects from the elements. If warehouse storage cannot be provided, materials and equipment shall be stacked well above ground level and protected from the elements with plastic sheeting or other method as appropriate.

3.3 MAGNESIUM ANODES

A. Anodes shall be installed in the trench horizontally as shown in the drawings after excavation to proper depth, equal to the bottom of the pipeline, a minimum of 3 feet from fittings and a minimum of 5 feet from the pipelines. Spacing between anodes shall be 10 feet (minimum) if multiple anodes are installed at a single test station location as shown on the drawings. Prior to placing anodes in the trench or hole, paper or plastic bags shall be removed, but the cloth bag shall remain around the anode. Care shall be exercised during installation to prevent damage to the cloth bag and loss of backfill material. After placing anodes in the trench, native soil, free of rocks and other foreign objects shall be placed around the anode to a minimum cover of one foot above the

anode. Remainder of the trench shall then be backfilled with native soil. During installation, anodes shall not be supported or handled by use of attached wires.

B. The number of anodes to be installed at each test station is designated on the drawings.

3.4 CABLES

A. Cables buried in the ground shall be direct buried and shall be laid straight, without kinks. The cable shall have a minimum cover of 30 inches. Each cable run shall be continuous in length and free of joints or splices. Care shall be exercised during installation to avoid punctures, cuts, and similar damage to insulation. Any damage to insulation will require replacement of the entire cable length. Backfill surrounding the cables shall be native soil free of foreign materials. Cable warning tape shall be installed 12-inches above the entire buried length of the cable.

3.5 CABLE-TO-PIPE CONNECTIONS

A. Exothermic Welds for Ductile Iron Pipe

1. Cable-to-pipe connections shall be installed in the manner and at the locations shown on the drawings. Coating materials shall be removed from the pipe surface over an area just sufficient to make the connections. The surface shall be cleaned to white metal by grinding or filing prior to welding the conductor. Grinding with resin-impregnated wheels shall not be allowed. The conductor shall be welded to the pipe by the exothermic process with a copper sleeve fitted over the conductor, and only sufficient insulation shall be removed from the conductor to allow placing in welding mold. After the weld has cooled, all slag shall be removed and the weld shall be tested with a sharp blow from a 22-ounce hammer to assure proper metallurgical bond. All defective welds shall be removed and replaced. All exposed surfaces of copper and steel shall be covered with a minimum thickness of ¼ inch of insulating materials as shown on the drawings. The cable to pipe connections shall be tested with a low resistance ohmmeter by the Contractor and approved by the Owner's Agent prior to backfill. Cable to pipe connections backfilled prior to testing shall be rejected.

B. Pin Brazing for Steel Pipe

1. Cut wire with a wire cutter to prevent deforming the wire ends. Do not deform the wire. Remove only enough insulation from the wire to allow the brazed connection to be made. The surface of the steel structure shall be ground or filed to a bright, shiny, clean and dry surface before brazing the wire connection. The attachment of the wire to the structure shall be made as indicated on the drawings. The wire is to be held at a 90 degree angle to the surface when brazing. Only one wire is to be attached with each braze. All wire to structure braze shall be a minimum of 6 inches apart. As soon as the braze has cooled, the brazed connection shall be tested for strength by striking a sharp blow with a two-pound hammer while pulling firmly on the wire. All unsound brazed connections are to be redone and retested. Assure that the area to be coated is thoroughly cleaned by wire brushing. All exposed surfaces of copper and steel and surrounding surface shall be cleaned of contaminants and covered with a minimum thickness of 1/4-inch of Propoxy 20 epoxy putty. The cable to pipe connections shall be tested with a low resistance ohmmeter by the Contractor and

approved by the Owner's Agent prior to backfill. Cable to pipe connections backfilled prior to testing shall be rejected.

3.6 TEST STATIONS

A. Test stations shall be installed at locations designated on the drawings and at all anode installation locations. All test stations shall be installed in the sidewalk. The terminal end of each cable shall be identified with the structure identification using the permanent cable identification tags.

3.7 JOINT BONDING

A. All non-welded rubber gasket joints, mechanical joints, flange joints and threaded joints shall be bonded with a #4 or #8 AWG/HMWPE stranded copper cable as shown on the drawings. The overall length of the conductor shall permit maximum movement of the pipe joint without transferring any tensile stress to the cable, per pipe manufacturer's recommendations. The bonded pipe sections shall be tested for continuity, prior to backfilling.

3.8 INSULATING FLANGED JOINTS

A. All insulating components of the insulating flanged gasket set shall be cleaned of all dirt, grease, oil and other foreign materials immediately prior to assembly. Bolt holes in mating flanges shall be properly aligned at the time bolts and insulating sleeves are inserted to prevent damage to the insulation. After flanged bolts have been tightened, each insulating washer shall be inspected for cracks or other damage. All damaged washers shall be replaced. After assembly, resistance between each bolt and flange shall be measured with an approved ohmmeter, and the minimum resistance shall be 50,000 ohms. Where the insulating joint is assembled in the shop and shipped as a unit, resistance shall be measured in the shop between the flanges and between each bolt and flange and shall meet the above requirements. In addition, the completed assembly shall be tested with a flange insulation tester such as Gas Electronics Model 601, or equal for the integrity of the insulation. In case where the insulating flange is assembled in the field the completed assembly shall be tested with a flange insulation tester such as Gas Electronics Model 601, or equal prior to backfilling. All insulating flanged joints shall be coated as shown on the drawings and specified below.

3.9 COATING INSULATING FLANGED JOINTS

A. Surfaces shall be cleaned of all dirt, grease, oil and other foreign materials immediately prior to coating. Remove loose rust, paint and other foreign matter in accordance with SSPC SP2 or SP3. A prime coating shall be applied in a uniform coating over the entire surface to be wrapped. A liberal coating shall be applied to threads, cavities, shoulders, pits and other irregularities. A fill coating shall be molded and packed onto irregular surfaces such as flanges, valves or flexible couplings to create a smooth profile prior to wrapping. A wrap coating shall be spirally wrapped using a minimum of 55 percent overlap to ensure a double thickness of material. At the completion of each roll the overlaps shall be smoothed by hand in the direction of the spiral to ensure sealing of the overlap. A 2-inch overlap shall be maintained when overlapping one roll with the end of a new roll. Overlap shall occur on the top half of the pipeline. A guard coating shall be spirally over-wrapped using a 55 percent overlap to ensure a double coating.

3.10 FIELD COATING OF BURIED FLANGE HARDWARE

A. All buried nuts and bolts shall be coated with bitumastic prior to polyethylene encasement. After flange hardware is installed use wire brush, power brush or an abrasive cleaning pad to remove all loose material, dirt and grime from substrate to a minimum cleanliness of SSPC SP2. Apply Bitumastic coating liberally with a medium bristle brush to the extent that all surfaces are completely covered with no bare spots visually evident. Coat exposed surfaces of bolts, washers and nuts, giving special attention to the bottom-side surfaces. Follow the manufacturer's recommendations for drying times required before polyethylene encasement and backfill.

3.11 ENCASEMENT FOR DUCTILE IRON

A. Encase all buried ductile iron pipe, valves, fittings and expansion joints of both the water mains and the water laterals in polyethylene sheeting in accordance with AWWA C-105/ANSI 21.5.

3.12 TAPE WRAP FOR COPPER PIPE

A. Prime copper pipe with Polyken 1027 primer, and install half-lapped Polyken 930 tape wrap.

3.13 ENERGIZING AND TESTING

A. All testing shall be performed by a corrosion engineer, registered in State of California, or by a NACE certified Cathodic Protection Specialist, or a NACE certified Corrosion Specialist to ensure conformance with the Contract Documents, NACE SP0169, and NACE SP0286. Notify the City Representative at least 5 working days prior to the testing. All testing shall be witnessed by the City Representative.

B. The native pipe-to-soil potential survey shall be performed prior to the backfill of the roadway. The survey shall be performed prior to the connection of the anode bed to the steel pipe. The survey shall be performed at the beginning and the end of the pipeline, at the midpoint between the beginning of the line and the first anode bed, at each anode bed and test station location, at the midpoint between the 2 consecutive anode beds, and at the midpoint between the last anode bed and the end of the pipeline. Pipe-to-soil potential at every discreet anode shall be recorded.

C. GPS coordinates shall be recorded for the locations of the anode test stations. The GPS coordinates shall be clearly identified in the cathodic protection activation report.

D. When the native pipe-to-soil potential survey is complete, connect the anode beds to the steel pipe through the test stations. Allow at least 72 hours for pipeline polarization. Perform the pipe-to-soil potential survey at the same locations as previously performed in step 3.13 B.

E. Test results and interpretation of the data shall be submitted to the City Representative for review and final approval.

F. Any defects shall be corrected by the Contractor prior to the backfill of the roadway, or as agreed upon by the City Representative.

G. Testing shall include the following and shall be conducted in accordance with NACE TM0497:

1. Verify electrical isolation at all insulating joints, insulating unions, and casing insulators per NACE SP0286.

2. Confirm electrical continuity of the pipeline or cathodically protected structure in accordance with this section.

3. Measure and record native structure-to-soil potentials at each location.

4. Measure and record the 'On' and 'Instant-off' structure-to-soil potentials at each location.

5. Measure and record the current outputs of each anode.

H. Test results shall be analyzed to determine compliance with NACE SP0169.

I. Test results shall be analyzed to determine if stray current interference is present. Stray current interference is defined as a shift in a pipelines pipe-to-soil potential by ±50 mV that is caused by a foreign current source. Stray current interference shall be tested on the project pipeline and foreign pipelines that have a reasonable chance of being affected by stray currents.

J. The Contractor shall provide a written report, prepared by the Corrosion Engineer documenting the results of the testing and recommending corrective work, as required to comply with the contract documents. Any deficiencies of systems tested shall be repaired and re-tested by the Contractor at no additional cost to the City.

END OF SECTION

SECTION 13120 – PREFABRICATED PEDESTRIAN BRIDGES

PART 1 GENERAL

1.1 THE REQUIREMENT

A. Furnish all materials, labor, equipment and incidentals necessary for the fabrication, erection and completion of all fabricated pedestrian bridges, including all bracing and shoring required for erection and related work. They shall include and not necessarily be limited to the following:

1. Fabricated Pedestrian Bridge, all primary and secondary structural members, connection bolts, anchor bolts, base plates, fasteners, and other miscellaneous items and accessories.

2. Anchor rods shall be furnished under this Section and set under Section 03300. Furnish anchor rods, nuts and metal setting templates. Furnish instructions for setting of anchor rods and ascertain that the items are properly set during and after progress of the Work. Verify anchor rod setting to assure adequate fit of fabricated pedestrian bridges

B. The CONTRACTOR is responsible for all aspects of the fabricated pedestrian bridge fabrication and installation including the design, fabrication and delivery by subcontractors.

C. These specifications are for fully engineered clear span pedestrian bridges of aluminum construction and shall be regarded as minimum standards for design and construction.

1.2 REFERENCE SPECIFICATIONS, CODES, AND STANDARDS

A. Governing Codes and Standards:

1. Bridges shall be designed in accordance with the California Building Code and the AASHTO, Guide Specification for Design of Pedestrian Bridges, latest edition, where applicable and unless otherwise stated in this section.

B. American Association of State Highway and Transportation Officials (AASHTO)

1. AASHTO, Guide Specification for Design of Pedestrian Bridges

C. Aluminum Association (AA)

1. Aluminum Association, Specifications and Guidelines for Aluminum Structures, latest edition

2. Aluminum Structures, A Guide to Their Specification and Design, latest edition

D. American Welding Society (AWS)

1. AWS D 1.2 – Structural Welding Code - Aluminum

E. International Code Council (ICC)

1. California Building Code

F. Where reference is made to one of the above standards, the revision in effect at the time of bid opening shall apply.

1.3 CONTRACTOR SUBMITTALS

A. Submit fabricated pedestrian bridge shop drawings, in accordance with Division 1, Shop Drawing Procedures, showing dimensions, material lists, methods of supporting, methods of anchoring and finishes.

B. Certification:

1. Supplier – Submit certification that the fabricated pedestrian bridge supplier is a manufacturer's authorized and franchised dealer of the system being furnished. Certification shall state date in which authorization was granted.

2. Erector – Submit certification that the pedestrian bridge installer has been regularly engaged in the installation of fabricated pedestrian bridges of the same or equal construction to the pedestrian bridges specified within these documents. Include lists of completed projects with project names and addresses, names and addresses of architects and owners, and other information specified.

C. Fabrication Drawings: Fabrication drawings and calculations shall be prepared and submitted for review after receipt of the order. Submittal drawings shall be unique drawings to this project, prepared to illustrate the specific portion of the bridges being fabricated. All relative design information such as member size, material specification, dimensions, and required critical welds shall be clearly shown on the fabrication drawings. Fabrication drawings shall have cross referenced details and sheet numbers. All fabrication drawings shall be stamped, and signed by a Professional Civil or Structural Engineer licensed in the state of California. A stamped electronic soft copy shall be provided for review and approval by the ENGINEER. At a minimum, the following criteria must be included for approval:

1. All relevant bridge dimensions.

2. Bridge cross sections.

3. Sufficient detailing.

4. Member cross sections.

5. General notes indicating material specifications.

6. Weld details.

7. Detail of bolted splices (if applicable).

8. Signature and seal of a Professional Civil or Structural Engineer licensed in accordance with this specification.

9. Camber details.

D. Calculations and Results: Structural analysis results and calculations shall be prepared and submitted for review after receipt of the order. All analysis and results necessary to determine the structural adequacy of the pedestrian bridges shall be shown. A stamped electronic copy shall be provided for review and approval by the ENGINEER. At a minimum, the following criteria must be included for approval:

1. Bridge reactions for all load combinations as outlined.

2. Expansion and contraction requirements and induced loads.

3. Critical weld analysis results.

4. Bolted splice calculations (if applicable).

5. Detailed description of applied loads and conditions for all load combinations.

6. Member maximum allowable for all load and design conditions.

7. Finite Element Analysis boundary conditions.

8. Finite Element Analysis data input.

9. Finite Element Analysis results and supplementary calculations for all stress and deflection analyses.

10. Finite Element Analysis results for frame stability analysis.

11. Finite Element Analysis results for frequency analysis.

1.4 QUALITY ASSURANCE

A. The fabricated pedestrian bridges shall be design by the Manufacturer as a complete system. All components of the system shall be supplied or specified by the same manufacturer (Single Source of Responsibility). The manufacturing company shall have a minimum of 10-years' experience in the manufacture of clear span aluminum pedestrian bridges.

B. Erector shall have specialized experience in the erection of fabricated pedestrian bridges for a period of not less than five years.

C. Qualifications:

1. Civil or Structural Engineer licensed to practice within the State of California. Experienced in providing engineering services of the kind indicated that have resulted in the installation of similar fabricated pedestrian bridges to this Project in material, design, and extent and that have a record of successful in-service performance.

2. Welders used for the Work are qualified in accordance with AWS D1.2.

D. Structural aluminum members shall be fabricated in accordance with Aluminum Association Design Manual and California Building Code.

E. Welding inspection shall be by an independent testing agency paid for by the CITY. All shop and field welding shall be inspected by an AWS certified welding inspector in accordance with AWS D1.1, Section 6. The CITY's Testing Agency shall provide the following:

1. Review of the Welding Procedure Specifications (WPS) submittal and verify that welders are performing work in accordance with the approved WPS.

2. Verification of welder's qualifications.

3. Verification that electrical meters being used accurately reflects voltage and amperage at the welding site for length of cable in use.

4. Visual Inspection – Visually inspect all welding in accordance with AWS D1.1 Section 6, and including verification, fit-up, preheat, calibration of equipment, equipment settings, materials, adherence to approved WPS, interpass temperatures, deposition rates, technique, proper fusion of each pass, ensure weld is crack free at each pass, confirm the final weld profile, and confirm that all special requirements specified herein are adhered to.

F. Fabrication and Erection Inspection by the CITY's Testing Agency – All fabrication and erection of fabricated pedestrian bridges shall be inspected by the CITY's Testing Agency. This inspection, in addition to the welding inspection requirements specified herein, shall consist of, but shall not necessarily be limited to the following:

1. Visually inspect structural shapes and plates for existence of defects. Use of ultrasonic equipment and other Non-Destructive-Testing (NDT) methods to determine extent of defects.

2. Review structural shapes for conformity to dimensional standards specified.

G. Welding, fabrication and erection inspection by the Testing Agency as required to satisfy building code requirements for special inspection will be paid by the CITY, unless specifically stated otherwise.

1. If inspection of shop fabrication requires the Testing Agency to travel further than 100 miles from the project site, the full cost of travel expenses incurred for such inspection shall be covered by the CONTRACTOR.

PART 2 PRODUCTS

2.1 MANUFACTURERS

A. Gator Dock and Marine, LLC, 2880 Mellonville Avenue, Sanford, Florida 32773.

B. MAADI Group, 400 Montfort, Suite 200, Montreal, QC, Canada H3C 4J9 Canada.

C. Niko Bridge and Marine Solutions, 55 East Paulding Drive, Dallas, GA 30159.

D. Or Approved Equal.

2.2 GENERAL FEATURES OF DESIGN

A. Pedestrian bridges, as defined in the Drawings and this section:

1. 88-foot pedestrian bridge from Area 23 to Area 22.

2. 72-foot pedestrian bridge from Area 22 to Area 21.

3. 8-foot pedestrian bridge from Area 22 to Area 51.

4. 33-foot pedestrian bridge at Area 21.

5. 33-foot pedestrian bridge at Area 22.

B. Span:

1. Bridge spans shall be as indicated on the Drawings.

C. Width:

1. Interior clear width of the walkway shall be not less than 36-inches.

D. System:

1. Bridges shall be “Cascade” style aluminum truss bridges, as defined in the Drawings and this Section, or similar in look and function.

2. Bridges shall be fabricated and delivered as continuous and pre-assembled structures unless mid-span splices are required.

3. Bridges shall be designed utilizing an H-section configuration, where the floor support system intersects the truss verticals above the bottom chord to increase stability.

4. Unless otherwise noted on the Drawings, bridges spanning greater than 35 feet shall be supported on independent footings or piers. Bridge loads to new or existing structures is not permissible without prior approval of the ENGINEER.

E. Camber:

1. Bridges shall be cambered to offset the dead load.

F. Slope:

1. Bridges shall be designed for abutments and/or piers constructed at the same elevation as indicated on the Drawings.

G. Deck:

1. Fabricated pedestrian bridges shall have an integrated, slip resistant, aluminum grate decking.

H. Bearing Pads:

1. Bridges shall include bearing pads, which shall allow the bridge to expand and contract as needed without binding.

I. Safety and Hand Rails:

1. Bridge shall incorporate a Combination Rail system consisting of vertical pickets, a graspable top rail, and curb bottom rail, which shall minimize climbing hazards and serve the function of guard, hand, and toe rail. The Combination Rail system shall meet all the dimensional requirements of FDOT Aluminum Pedestrian/Bicycle Picket Railing – Index No. 860 or equal.

   a. Top of top rail shall not be less than 42” above the finished deck. Refer to Drawings.

   b. Clear opening between pickets shall reject the passage of a 4” diameter sphere.

   c. Clear opening between bottom rail and finished deck shall reject the passage of a 2” diameter sphere.

   d. Graspable portion of top rail shall be round with a 1¼” to 2” OD or equivalent gripping surface.

   e. Ends of handrails shall be returned smoothly to floor or posts.

   f. A 1.5” clear distance between wall and top rail must be maintained.

   g. All geometry is to be smooth with no sharp corners

2.3 ENGINEERING

A. Design loads for pedestrian bridges: Comply with the requirements set forth by AASHTO for pedestrian bridges.

1. Dead Load

   a. The bridges shall be designed considering its own dead load including structure and originally designed decking only. No additional loads shall be considered.

2. Pedestrian Live Load

   a. Main supporting members, including trusses, primary beams, and arches shall be designed to comply with the requirements set forth by AASHTO for pedestrian bridges.

   b. Secondary members, including deck and supporting floor system shall be designed to comply with the requirements set forth by AASHTO for pedestrian bridges.

3. Wind Loads:

   a. Comply with wind provisions set forth in Section 01614 – Wind Design Criteria.

4. Seismic Loads:

   a. Comply with seismic provisions set forth in Section 01612 – Seismic Design Criteria.

5. Top Chord/Rail Load

   a. The top chord, top rail, and vertical posts shall be designed for a simultaneous vertical and horizontal load of 50 pounds per linear foot or a 200-pound point load, whichever is greater, positioned to produce the maximum load effect.

6. Foundation Systems: Geotechnical report has been prepared for the Work by CAL Engineering and Geology, Inc. A copy of the report is on file at the Office of the Engineer and may be reviewed with proper advanced Notification.

   a. Continuous and Isolated Footings:

      1) May be designed to impose a maximum allowable bearing pressure of 3,000 pounds per square foot (psf) on foundation soils when considering dead plus normal live loading. This allowable foundation soil pressure may be increased by one-third when considering short term wind and seismic loading. Footings shall be embedded a minimum of 24-inches below the lowest adjacent finished grade.

      2) Soil resistance to lateral loads will be provided by a combination of 0.40 Coefficient of Friction resistance between the bottom of the footings and underlying soil and by passive pressure of 400 psf (Equivalent Fluid Pressure) acting against the embedded sides of the footing.

      3) Long-term settlement of the foundation system relative to surrounding ground surface is anticipated to be less than 1-inch, with differential settlements on the order of ½-inch or less for a distance of 30-feet.

   b. Drilled Piers:

      1) Allowable Skin Friction (Dead plus normal Live Load): 600 psf, may be increased by one-third for seismic loading. Skin friction shall be ignored for the first 12-inches of soil material.

      2) Allowable Skin Friction, Uplift: 400 psf.

      3) End bearing capacity of the piers shall be neglected.

4) Lateral loads (static and seismic) shall be resisted by passive equivalent fluid pressure of 360 pounds per cubic foot (pcf) above groundwater level and 235 pcf below groundwater level; acting on 1½ times the pier diameter. The upper 2-feet of site soil shall be ignored when determining lateral load resistance capability of the piers.

5) Piers shall be at least 18-inches in diameter and extend at least 10-feet below compacted pad grade.

7. Structural Performance of Handrail Assemblies / Guardrail Systems – Engineer, fabricate, and install guardrails and handrails in accordance with the California Building Code and tested in accordance with the requirements of ICC-ES AC273, and the following minimum requirements:

a. All handrail assemblies and guardrail systems shall be designed to resist a single concentrated load of 200 lbs applied in any direction at any point along the top and to transfer this load through the supports to the structure. This load need not be assumed to act concurrently with the 50 lb/ft specified below.

b. All handrail assemblies and guardrail systems shall be designed to resist a load of 50 lb/ft (pound force per linear foot) applied in any direction at any point along the top and to transfer this load through the supports to the structure. This load need not be assumed to act concurrently with the 200 lb load specified above.

c. All handrail assemblies and guardrail systems shall be designed for a maximum horizontal deflection at the prescribed loads, measured at the line of the vertical support, of rail height divided by 60, with rail height being the distance between the surface of the post anchorage and the top of the top rail.

d. Reductions in the aforementioned prescribed loads for building classification and/or occupancy permitted by governing Codes and/or Standards are not permissible.

B. Design Limitations

1. Deflection

a. The vertical deflection of the main truss due to any load combination shall not exceed L/360, where L is the length of the unsupported span.

b. The horizontal deflection of the structure due to any load combination shall not exceed L/500, where L is the length of the unsupported span.

2. Allowable Stresses

a. All allowable stresses for aluminum shall be determined in accordance with the Aluminum Association, Specifications and Guidelines for Aluminum Structures, supplemented by Aluminum Structures, A Guide to Their Specification and Design. Allowable stresses are to be reduced to account for effects due to welding and/or fatigue where applicable. Allowable

stresses for Load Combinations which include wind loads may be increased by 25%.

3. Frame Stability

a. The buckling load factor for the bridge structure shall be no less than 4 for any combination of applied loads, to ensure adequate overall stability and stiffness.

4. Vibration

a. The fundamental frequency of the unloaded pedestrian bridges shall be no less than 3.0 Hz to avoid the first harmonic.

C. Analysis

1. Full structural analyses for the primary bridge structure shall be completed using a 3D finite element analysis. All member end conditions are to be considered fixed. Other analysis methods may be used for secondary members. All analysis and results necessary to determine the structural adequacy of the bridges shall be reported. The following analyses are required:

2. Stress, Deflection and Frame Stability

a. Analysis shall be completed to determine that all bridge members, critical connections, and bridge configurations are sufficient to adequately resist the load combinations presented in the CBC using loads defined within this specification section and the CBC.

b. Buckling analysis shall be completed to determine that the bridge frame is adequately stable and sufficient to resist forces causing it to buckle.

3. Frequency

a. Frequency analysis shall be completed to determine that the bridge frame is sufficient to avoid resonance due to frequencies encountered under normal use when subjected to the loads defined within this specification section and the CBC.

2.4 MATERIALS

A. Structural Members

1. All primary structural members are to be 6061-T6 aluminum for its high strength and corrosion resistance. Secondary members are to be 6000 series aluminum for corrosion resistance. All metal components (primary and secondary structure, deck pan, railings) shall be PVDF finish as follows:

a. High-Performance Organic Finish: Three-coat fluoropolymer finish complying with AAMA 2605 and containing not less than 70 percent PVDF resin by weight in both color coat and clear topcoat. Prepare, pretreat, and apply coating to exposed metal surfaces to comply with coating and resin manufacturers' written instructions.

b. Color and Gloss: As selected by Architect from manufacturer's full range.

B. Deck: Integrated, slip resistant, aluminum grate decking.

C. Bearing Pads: All bearing pads shall be 1” thick UHMW adequately dimensioned to provide support to the structure over the full travel resulting from expansion and contraction.

D. Fasteners: All fasteners required for assembly shall be stainless steel type 304. Insulating washers shall be provided where stainless steel and aluminum contact is anticipated to minimize the potential for galvanic action.

PART 3 EXECUTION

3.1 FABRICATION AND ASSEMBLY

A. Welding: All aluminum members shall be welded using 5356 aluminum filler wire in accordance with AWS D1.2

B. Expansion Slots: Slots shall be cut into bridge bearing areas to allow for proper expansion and contraction of the bridges.

C. Mid-Span Splices: When required to accommodate Contractor requirements or those of this Section, mid span splices shall be incorporated and be adequately designed to meet all criteria specified in the Contract Documents. Mid-span splices shall be designed and fabricated in accordance with the Aluminum Association, Specifications and Guidelines for Aluminum Structures, supplemented by Aluminum Structures, A Guide to Their Specification and Design.

END OF SECTION

SECTION 13340 – METAL BUILDING SYSTEMS

PART 1 GENERAL

1.1 THE REQUIREMENT

A. Furnish all materials, labor, equipment and incidentals necessary for the fabrication, erection and completion of all metal building systems, including all bracing and shoring required for erection and related work. They shall include and not necessarily be limited to the following:

1. Unless otherwise indicated on the Drawings, the following buildings shall be metal building systems:

   a. Blower/Electrical/Maintenance Building (Area 27).

   b. Dryer Building (Area 52).

   c. Biosolids Storage Building (Area 53).

2. Metal Building System, all primary and secondary structural members, connection bolts, anchor bolts, base plates, canopies, roof extensions, sheeting, trim, flashing, fasteners, gutters, downspouts, and other miscellaneous items and accessories.

3. Anchor rods shall be furnished under this Section and set under Section 03300. Furnish anchor rods, nuts and metal setting templates. Furnish instructions for setting of anchor rods and ascertain that the items are properly set during and after progress of the Work. Verify anchor rod setting to assure adequate fit of metal building system.

4. For Seismic Design Criteria, refer to Section 01612.

5. For Wind Design Criteria, refer to Section 01614.

6. For concrete work, refer to Division 3.

7. For Structural Steel and Miscellaneous Metal work, refer to Division 5.

8. For Thermal Insulation, refer to Section 07210.

9. For Formed Metal Roof and Wall Panels, refer to Section 07415.

10. For Steel Doors and Frames, refer to Section 08110.

11. For Overhead Coil Doors, refer to Section 08332.

12. For Metal Sound Control Doors, refer to Section 08349.

13. For High Performance Coatings, refer to Section 09960.

14. For Top Running Double Girder Bridge Cranes, refer to Section 14633.

1.2 REFERENCE SPECIFICATIONS, CODES, AND STANDARDS

A. American Association of State Highway and Transportation Officials (AASHTO)

1. Standard Specification for Highway Bridges.

B. American Institute of Steel Construction (AISC)

1. Specifications for the Design, Fabrication and Erection of Structural Steel for Buildings.

2. Specification for the Design of Cold-Formed Steel Structural Members.

3. Code of Standard Practices for Steel Buildings and Bridges with Commentary.

4. Structural Steel Detailing Manual.

5. Steel Construction Manual

C. ASTM International (ASTM)

1. ASTM A6 – Standard Specification for General Requirements for Rolled Steel Plates, Shapes, Sheet Piling, and Bars for Structural Use

2. ASTM A36 – Standard Specification for Structural Steel

3. ASTM A123 – Standard Specification for Zinc (Hot Dipped Galvanized) Coatings on Iron and Steel Products.

4. ASTM A153 – Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware.

5. ASTM A307 – Standard Specification for Carbon Steel Bolts and Studs, 60,000 psi Tensile Strength.

6. ASTM A325 – Standard Specification for High Strength Bolts for Structural Steel Joints.

7. ASTM A446 – Standard Specification for Steel Sheet, Zinc Coated (Galvanized) by the Hot-Dip Process, Structural (Physical) Quality.

8. ASTM A500 – Specifications for Cold-Formed Welded and Seamless Carbon Steel Structural Tubing Rounds and Shapes.

9. ASTM A501 – Standard Specification for Hot-Formed Welded and Seamless Carbon Steel Structural Tubing.

10. ASTM A525 – Standard Specification for General Requirements for Steel Sheet, Zinc-Coated (Galvanized) by the Hot-Process.

11. ASTM A563 – Standard Specification for Carbon and Alloy Steel Nuts.

12. ASTM A572 – Standard Specification for High-Strength Low-Alloy Columbium-Vanadium Structural Steel.

13. ASTM A653 – Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy Coated (Galvannealed) by the Hot-Dip Process

14. ASTM A780 – Standard Practice for Repair of Damaged and Uncoated Areas of Hot-Dip Galvanized Coatings

15. ASTM A992 – Standard Specification for Structural Steel Shapes.

16. ASTM A1011 – Standard Specification for Steel, Sheet and Strip, Hot-Rolled, Carbon, Structural, High-Strength Low-Alloy, High-Strength Low-Alloy with Improved Formability, and Ultra-High Strength.

17. ASTM B633 – Standard Specification for Electrodeposited Coatings of Zinc on Iron or Steel

18. ASTM D1494 – Test Method for Diffuse Light Transmission Factor of Reinforced Plastic Panels

19. ASTM F436 – Standard Specification for Hardened Steel Washers

20. ASTM F959 – Standard Specification for Compressible-Washer-Type Direct Tension Indicators for Use with Structural Fasteners

21. ASTM F1554 – Standard Specification for Anchor Bolts, Steel, 36, 55 and 105-ksi Yield Strength

22. ASTM F3125 – Standard Specification for High Strength Structural Bolts, Steel and Alloy Steel, Heat Treated, 120 ksi and 150 ksi Minimum Tensile Strength

D. American National Standards Institute (ANSI)

1. ANSI B18.22.1 – Plain Washers

2. ANSI B18.23.1 – Beveled Washers

3. ANSI Z49.1 – Safety in Welding and Cutting

E. American Society of Civil Engineers (ASCE)

1. ASCE/SEI 7 – Minimum Design Loads for Buildings and Other Structures.

F. American Welding Society (AWS)

1. D1.1 Structural Welding Code – Steel with Amendments

2. D1.3 Structural Welding Code – Sheet Steel

G. Crane Manufacturers Association of America (CMAA)

1. Specification Number 70 – Specifications for Top Running Bridge and Gantry Type Multiple Girder Electrical Overhead Travelling Cranes

H. Federal Specifications and Standards

1. Federal Standard 595B

I. International Accreditation Service (IAS)

1. AC472 – Accreditation Criteria for Inspection Programs for Manufacturers of Metal Building Systems

J. International Code Council (ICC)

1. California Building Code

K. Metal Building Manufacturers Association (MBMA)

1. Building Systems Manual

L. National Association of Corrosion Engineers (NACE)

1. Coating Inspector Program (CIP)

M. Research Council on Structural Connections of the Engineering Foundation (RCSCEF)

1. Specifications for Structural Joints using ASTM A325 or ASTM A490 Bolts.

N. Steel Deck Institute (SDI)

1. SD1 DDM01 – Steel Deck Institute's Design Manual for Composition Decks, Form Decks, and Roof Decks.

O. Steel Door Institute (SDI)

1. A250.8 – Recommended Specifications for Standard Steel Doors and Frames

P. Steel Structural Painting Council Specification (SSPC)

1. Surface Preparation Standards

Q. U.S. Army Corp of Engineers

1. Guide Specification 07416 – Test Method for Structural Performance of Standing Seam Metal Roof Systems by Uniform Static Air Pressure.

R. Underwriter's Laboratory (UL)

1. UL 580 – Standard for Uplift Resistance of Roof Assemblies.

S. Where reference is made to one of the above standards, the revision in effect at the time of bid opening shall apply.

1.3 CONTRACTOR SUBMITTALS

A. Prior to preparation of submittals, Contractor shall prepare for and conduct a separate Pre-Submittal Meeting for each Metal Building System. Pre-submittal meeting shall be attended by Contractor, Metal Building Systems Supplier, plumbing and HVAC subcontractors (if different than Contractor), Fire Suppression/Sprinkler sub-contractor (if different than Contractor), Electrical subcontractor and Process Control System Integrator. The supplier of the Section 11502 Geared Centrifugal Blower Package will attend the Blower/Maintenance Building Pre-Submittal Meeting. The supplier of the

Section 11600 Biosolids Dryer System shall attend the Biosolids Dryer Building Pre-Submittal Meeting. Each of these attendees shall be prepared to discuss any requirement that may impact the Building sizing or other aspect that must be known by the Metal Buildings Systems supplier. Owner, Construction Manager and Design Professional shall attend.

B. Contractor will coordinate Metal Building System submittals with the trades and suppliers mentioned in 1.3 A prior to submittal. Uncoordinated submittals will be returned without review.

C. Mill Test Reports – CONTRACTOR or designee shall furnish certified copies of all mill analysis and test reports covering the chemical and physical properties of the steel for review by the CITY's Testing Agency.

D. Certification:

1. Manufacturer:

a. Submit proof of AISC-MB (Category – Metal Building) Certification. This certification is to cover areas of general management, engineering and drafting, procurement, operations and quality control.

b. Submit evidence of manufacturer’s certification under IAS AC 472.

2. Supplier:

a. Submit certification that the metal building system supplier and/or metal roof system supplier is a manufacturer's authorized and franchised dealer of the system being furnished. Certification shall state date in which authorization was granted.

3. Erector:

a. Submit certification that the building and/or roofing system installer has been regularly engaged in the installation of metal building systems of the same or equal construction to the system specified within these documents. Include lists of completed projects with project names and addresses, names and addresses of architects and owners, and other information specified.

4. Structural Design – Submit a written letter of certification prepared and signed by a Professional Civil or Structural Engineer, licensed within the State of California, verifying that the metal building system design and metal roof system design (including panels, clips, support system components and additional structural elements at/around wall and roof penetrations) meet the indicated loading requirements and specified building code. The certification shall reference specific dead, live, wind loads/speed (including edge zone wind pressures) tributary area loading reductions (if applicable) concentrated loads, collateral loads, seismic loads, end use category and load applications.

E. Submit heat gain-loss calculations to demonstrate compliance with CCR Title 24.

1. Metal Roofing System – Submit certification that the metal roofing system has been tested and approved by:

a. Underwriters Laboratory as Class 90

b. US Army Corp of Engineers Guide Specification 07416 "Test Method for Structural Performance of Standing Seam Metal Roof Systems by Uniform Static Air Pressure"

2. Welding:

a. Submit welder's certification demonstrating that welders used for the Work are qualified in accordance with AWS D1.1, within the previous 12-months.

b. Welding Procedure Specifications (WPS) – CONTRACTOR or designee shall submit welding procedure specifications and procedure qualification records (PQR) for all welded joint types.

F. Descriptive Data: Submit data for the following items, either on the shop drawings or separately:

1. Accessories, each type of flashing, trim closures, caps and similar items, fasteners, doors, roof openings, wall openings, gutters and downspouts.

G. Samples – Samples shall be used as a basis for evaluating quality of finished roof system. Submit two each of the following:

1. 12-inch long by actual width of roofing, linear panel, with required finish.

2. Fasteners (including standing seam roof clips) for application of roofing and soffit panels.

3. 12-inch long by 12-inch wide (minimum) of actual standing seam side lap seams for both sides of a typical panel, including sealants and closures.

4. Where finishes involve normal color and texture variations, include sample sets showing full range of variations expected.

H. Product Data:

1. Submit manufacturer's product information, specifications and installation instructions for building components and accessories.

2. Manufacturer's standard color charts and profiles:

a. Exterior roof, wall and soffit panels.

b. Gutters and downspout trim.

3. Manufacturer's list of approved clamps that may be used to hang suspended items from roof purlins and details of acceptable methods of attachment to roof purlins.

I. Shop/Erection Drawings – Submit erection drawings showing roof framing, transverse cross-sections, covering and trim details and accessory installation details that clearly indicate proper assembly of building components. Erection drawings shall include location and size of all wall and roof penetrations, including but not limited to doors, louvers, pipe and conduits penetrations and equipment penetrations.

J. Submit to the ENGINEER data showing the location, magnitude and direction of all dead, live, wind and or seismic loading reactions imposed on the structure by the metal building system.

K. Record Documents:

1. One set of reproducible “Record Drawings” for the erected structure.

2. Drawings shall bear the seal of a Professional Engineer, registered in the state of California and who provided responsible charge for the design.

L. Closeout Submittals: Submit Contract Closeout Submittals:

1. Operating and Maintenance Information.

2. Warranty.

3. Certificate of Compliance: At completion of the metal building manufacture, the manufacturer will furnish a letter to the ENGINEER stating that the work was performed in accordance with the approved construction documents and site inspections were completed as specified herein.

1.4 QUALITY ASSURANCE

A. The building shall be design by the Manufacturer as a complete system. All components of the system shall be supplied or specified by the same manufacturer (Single Source of Responsibility).

B. The manufacturing company shall have a minimum of 10-years’ experience in the manufacture of metal building systems, including:

1. Certification by IAS AC472 Accreditation.

2. Engineer of Record shall hold a current Civil or Structural Engineer’s license in the State of California.

C. Erector shall have specialized experience in the erection of steel building systems of similar complexity for a period of not less than five years, as well as:

1. Shall be trained, approved and certified by the manufacturer prior to Bidding of the Project;

2. Direct experience in a minimum of two installations larger than 5,500 square-feet with a minimum eave height of 37 feet; and

3. Direct experience in a minimum of two installations with travelling bridge crane(s).

D. Qualifications:

1. Building System Manufacturer shall be American Institute of Steel Construction (AISC) – Category MB Certified.

2. Civil or Structural Engineer licensed to practice within the State of California. Experienced in providing engineering services of the kind indicated that have resulted in the installation of similar metal building systems to this Project in material, design, and extent and that have a record of successful in-service performance.

3. Welders used for the Work are qualified in accordance with AWS D1.1.

E. Structural steel members shall be fabricated in accordance with MBMA Metal Building Systems Manual, AISC – Specifications for Structural Steel Buildings and California Building Code.

F. High strength bolts, nuts, washers and threaded rods shall be sampled and tested in accordance with the requirements of the specification for High Strength Bolts for Structural Steel Joints, ASTM A325 or ASTM A490 Bolts.

G. Welding inspection shall be by an independent testing agency paid for by the CITY. All shop and field welding shall be inspected by an AWS certified welding inspector in accordance with AWS D1.1, Section 6. The CITY's Testing Agency shall provide the following:

1. Review of the Welding Procedure Specifications (WPS) submittal and verify that welders are performing work in accordance with the approved WPS.

2. Verification of welder's qualifications.

3. Verification that electrical meters being used accurately reflects voltage and amperage at the welding site for length of cable in use.

4. Visual Inspection – Visually inspect all welding in accordance with AWS D1.1 Section 6, and including verification, fit-up, preheat, calibration of equipment, equipment settings, materials, adherence to approved WPS, interpass temperatures, deposition rates, technique, proper fusion of each pass, ensure weld is crack free at each pass, confirm the final weld profile, and confirm that all special requirements specified herein are adhered to.

H. Fabrication and Erection Inspection by the CITY's Testing Agency – All fabrication and erection of metal building systems shall be inspected by the CITY's Testing Agency. This inspection, in addition to the welding inspection requirements specified herein, shall consist of, but shall not necessarily be limited to the following:

1. Visually inspect steel shapes and plates for existence of defects such as laminations and non-metallic inclusions. Use of ultrasonic equipment and other Non-Destructive-Testing (NDT) methods to determine extent of defects.

2. Verify steel materials with mill certificates. Verify weld filler metal materials with certificates and manufacturer's recommended limitations.

3. Review rolled shapes for conformity to dimensional standards specified.

4. Inspect high strength bolting for conformance with ASTM A325 or ASTM A490.

I. Welding, fabrication and erection inspection by the Testing Agency as required to satisfy building code requirements for special inspection will be paid by the CITY, unless specifically stated otherwise.

1. If inspection of shop fabrication requires the Testing Agency to travel further than 100 miles from the project site, the full cost of travel expenses incurred for such inspection shall be covered by the CONTRACTOR.

J. Unless otherwise directed by the ENGINEER, the CONTRACTOR shall provide the services of an independent NACE certified coating inspector. The cost of such work, except as specifically stated otherwise, shall be paid by the CONTRACTOR. All shop-applied coatings shall be inspected by an inspector, qualified in accordance with NACE requirements and approved by the ENGINEER.

1.5 WARRANTY

A. Provide CITY with warranty that exterior finish system for metal panels shall be guaranteed against blister, peeling, cracking, chipping or material rust-through for a period of 20-years from the date of Substantial Completion.

B. Provide CITY with warranty stating that the metal building system shall be guaranteed against water leaks arising out of or caused by ordinary wear and tear by the elements for a period of 10-years from the date of Substantial Completion.

1.6 DEFINITIONS

A. Primary Structural Framing – Any built-up, hot-rolled, or cold-formed columns or framing systems that support the secondary framing members and transfers their loads directly to the structure's foundation.

B. Secondary Structural Framing – Any cold-formed, hot-rolled, or built-up purlins, girts, struts, bracing, or beams which transfer their loads from the cladding to the primary structural framing to which they are attached.

1.7 SYSTEM DESCRIPTION

A. System:

1. Design:

a. Furnish metal building systems with vertical walls, gable and butterfly roofs and with column layout, bracing location as indicated on the Drawings.

b. Deviations are subject to review and acceptance by the ENGINEER.

2. Size:

a. Furnish metal building systems of the size and configuration indicated on the Drawings.

b. Coordinate manufacturer's design dimensions for metal building system components, including columns, with equipment foundations, and details indicated on the Drawings.

3. Roof Slope: Use a roof slope as shown on the Drawings.

4. Provide buildings with horizontal and vertical bracing where indicated on the Drawings or as required by design.

5. Openings: Frame openings for doors, windows, louvers, and equipment with structural framing to replace panels and secondary framing cut for opening.

1.8 DESIGN

A. The strength, serviceability and quality for materials and design procedures shall meet the requirements of the following Codes and Standards:

1. MBMA – Metal Building Systems Manual

2. 2016 California Building Code

3. Supplemental Codes and Standards:

a. ASCE/SEI 7 – Minimum Design Loads for Buildings and Other Structures.

b. AISC – Steel Construction Manual

c. ICC-ES and/or IAPMO-UES reports for specific products, as needed.

d. AASHTO – Standard Specification for Highway Bridges – Loading

4. Seismic Design Criteria – In accordance with pertinent sections of the California Building Code and ASCE 7. See also Section 01612 for seismic design parameters.

5. Wind Design Criteria – In accordance with pertinent sections of the California Building Code and ASCE 7. See also Section 01614 for wind design parameters.

B. Rainfall intensity – All exterior gutters and downspouts shall be designed for rainfall intensity based upon a five-year recurrence interval with five-minute duration. All interior gutters, valleys and downspouts shall be designed for rainfall intensity based upon a 25-year recurrence interval with five-minute duration.

C. Collateral Loads – Additional imposed loads other than the weight of the metal building system. These added loads could include such items as, but not limited to, mechanical and electrical systems. The actual loads imposed by these systems on the metal building structure shall be used for design, or 10 pounds per square foot collateral load, whichever is greater.

D. Crane Loading: As required for crane(s) specified in Section 14633.

E. Design Structure for Open, Enclosed, and Partially Enclosed – All metal building systems for this Project shall be designed as open structures, enclosed or partially enclosed, whichever results in the most stringent design for the structure and its elements.

F. Deflection:

1. Deflection requirements shall be in accordance with the applicable provisions of the AISC Steel Design Guide Series 3 – Serviceability Design Considerations for Steel Buildings and the specified building code.

2. Calculations for deflections shall be done using only the bare frame method. Reductions based on engineering judgment using assumed composite stiffness of the building envelope shall not be allowed. Drift shall follow AISC "Serviceability Design Considerations for Low-Rise Buildings".

3. The use of composite stiffness for deflection calculations is permitted only when actual calculations for the stiffness are included within the design.

4. Due to close proximity of adjacent building, maximum permissible elastic deflection (δ_{max}) shall be 6-inches.

G. Anchor Rods – Anchor rods and base plates shall be designed to resist all column reactions. Sizes used shall be those shown on the shop/erection drawings.

1. Where the design of the anchor rods requires the addition of supplementary concrete reinforcing steel to protect against concrete failure modes, the design of the supplementary reinforcing steel shall be included as part of the submitted anchorage calculations. The supplementary concrete reinforcing steel shall be treated as part of the required building anchorage and shall be provided and installed at no additional cost to the CITY.

H. Thermal Effects:

1. Standing Seam roof panels shall be free to move in response to the expansion and contraction forces resulting from a temperature variation. Assemble to permit movement of components without buckling, failure of joint seals, undue stress on fasteners or other detrimental effects, when subject to the specified temperature change.

2. Temperature Change (Range): Allowance for thermal movement shall be based on temperature change of plus or minus 100 degrees-F from the average ambient temperature at the project site, or from the temperature at time of installation, whichever is more stringent.

I. Lateral Loads – Metal building systems for this Project shall be designed for all lateral loads including wind and seismic. Design shall include moment frames or other open system which does not obstruct the area between the columns. Diagonal bracing between columns to resist lateral loads will not be acceptable.

1.9 ADMINISTRATION

A. All nomenclature shall conform to the MBMA Metal Building Systems Manual.

B. Coordination and administration of the Work shall be in accordance with the MBMA Metal Building Systems Manual – Common Industry Practices.

1.10 DELIVERY, HANDLING AND STORAGE

A. All materials shall be delivered promptly so as to cause no delay with other parts of the Work. Stored materials shall be placed on skids and not on the ground and shall be piled and blocked-up so that they will not become bent or otherwise damaged. Materials shall be stored away from uncured concrete and protected from weather, moisture, soiling, abrasion, extreme temperatures and humidity. Materials shall be handled with cranes and derricks as far as practical. Materials shall not be dumped off cars or trucks, nor handled in any other manner likely to cause damage. Materials with excessive damage, in the opinion of the ENGINEER, shall not be incorporated into the Work and shall be removed and replaced with new, undamaged, materials by the CONTRACTOR, at no additional expense to the CITY.

1.11 FIELD MEASUREMENTS

A. CONTRACTOR shall verify all field measurements as indicated on the shop/erection drawings prior to fabrication of assemblies.

PART 2 PRODUCTS

2.1 GENERAL REQUIREMENTS

A. The use of manufacturer's name and model or catalog number is for the purpose of establishing the standard of quality and general configuration desired.

B. Single Source Responsibility – Obtain metal building systems from single manufacturer in order to provide standardization of appearance.

C. Design work to comply with applicable requirements of article titled "Quality Assurance."

2.2 STRUCTURAL FRAMING

A. Unless otherwise specified, the minimum standard design thickness of structural framing shall be as follows:

1. Webs of welded built-up members – 0.125 inches

2. Flanges of welded built-up members – 0.175 inches

3. Cold-formed secondary framing – 0.060 inches

4. Cable bracing – 0.250 inches

5. Rod bracing – 0.625 inches

6. Angle bracing – 0.1875 inches

B. All hot-rolled sheet, plate, and strip steel used in webs from 0.125 inches up to 0.175 inches shall conform to the provisions of ASTM A1011, Grade 55 with minimum yield strength of 55,000 psi. All thickness greater than 0.175 inches (to 0.5 inches inclusive) shall conform to ASTM A572, Grade 55 with minimum yield strength of 55,000 psi.

C. All hot-rolled flat bars used in flanges shall conform to the provisions of ASTM A572, Grade 55; with minimum yield strength of 55,000 psi.

D. All wide-flange, channel, and "S" shapes shall conform to the provisions of ASTM A36, ASTM A572 or ASTM A992, as applicable. All hollow structural sections shall conform to ASTM A500, Grade B.

E. All hot-rolled or cold-rolled sheet and strip steel less than 0.150-inches thick used in fabrication of cold-formed structural members shall conform to ASTM A1011, Grade 55, with a minimum yield strength of 55,000 psi.

F. Light-gauge cold-formed sections shall be manufactured by roll or brake-forming. All dimensions shall be fabricated to MBMA tolerances.

G. Fasteners:

1. Structural Steel Bolts – ASTM A325 or A307

2. Carbon Steel Plain Washers – ANSI B18.22.1

3. Carbon Steel Beveled Washers – ANSI B18.23.1

4. Roof Panels to Structural Steel – At a minimum, #14 TEK III with ¾-inch hex head and neoprene washer, or approved equal.

5. Gutter Facia Trim to Roof Panels – At a minimum, #8 TEK III with ½-inch hex head and neoprene washer, or approved equal.

6. Sheet Metal Screws – Cadium or Zinc Plated.

H. Roof and wall panels: As specified in Section 07415.

I. Wall Opening Removable Covers: Exterior and inner wall opening covers shall be of similar material, profile, texture, perforation pattern (where applicable), insulation, and finish as specified for wall panels.

1. Removable wall covers shall be sealed air-tight with neoprene gasketing both for inner and exterior covers.

2. Provide steel sleeves through full depth of each wall openings and fully welded in-place.

J. Gutters and Downspouts:

1. Material: AZ50/Galvalume/Zincalume per ASTM A792.

2. Gauge: 24 gauge.

3. Finish: Valspar Fluropon “high build” paint finish up to 2.4 mil.

a. Color: Downspouts, match wall panels.

b. Color: Gutters, match roof panels.

K. Doors and Frames: Provide doors and frames as indicated on the Drawings and as specified in Sections 08110, 08332 and 08346.

L. Insulation:

1. Insulate removable covers over wall openings for future pipe penetrations to same minimum thickness, acoustical characteristics and thermal value as required for remaining walls in building.

2. Thermal Value:

a. Roof Insulation: Comply with minimum R-Value requirements in accordance with California Code of Regulations Title 24 or as noted on Drawings.

b. Wall Insulation: Comply with minimum R-Value requirements in accordance with California Code of Regulations Title 24 or as noted on Drawings.

M. Caulking Material: elastomeric type, manufacturer's standard.

N. Windows and Glazing:

1. Provide windows and glazing as indicated on the Drawings and as specified in Sections 08410 and 08800.

2.3 WELDING:

A. Method - All welding shall be by the metal-arc method or gas-shielded arc method as described in the American Welding Society's "Welding Handbook" as supplemented by other pertinent standards of the AWS. Qualification of welders shall be in accordance with the AWS Standards governing same.

B. Welding electrodes shall meet the minimum requirements of E70XX. Filler metal shall conform to Table 3.1 of AWS D1.1. Electrodes and equipment settings shall be as recommended by the filler metal manufacturer for the position, thickness or other conditions of actual use.

C. All electrodes and filler metals shall be low hydrogen types. Filler metals with E70-T4 designation shall not be used.

D. Welds in moment connections shall have a minimum CVN value of 20-ft-lb at 0 degrees F.

E. Quality - In assembly and during welding, the component parts shall be adequately clamped, supported and restrained to minimize distortion and for control of dimensions. Weld reinforcement shall be as indicated by the AWS Code. Upon completion of welding, all weld splatter, flux, slag, and burrs left by attachments shall be removed. Welds shall be repaired to produce a workmanlike appearance, with uniform weld contours and dimensions. All sharp corners of material to be painted or coated shall be ground to minimum of 1/32-inch on the flat.

2.4 PAINTING

A. Clean and prepare in accordance with SSPC-SP2 as a minimum.

B. Shop Coat Paint

1. Primary structural members shall be dark iron oxide, identified as color number 30111 by the Federal Standard 595B. Dry film thickness to be 1.0±mil.

2. Secondary structural members shall be dark iron oxide, identified as color number 30111 by the Federal Standard 595B. Coating applied by the vacuum coated process to a dry-film-thickness between 0.7-0.9 mil.

3. Paint shall meet the performance characteristics of SSPC-SP15.

4. Refer to Section 09900 Painting, for additional information.

5. The CONTRACTOR or designee shall notify the CITY at least four weeks in advance of surface preparation and painting in the fabricator's shop so that a local, independent, NACE paint inspector, can provide local inspection and dry film testing before steel leaves the shop. The cost for the independent NACE paint inspector will be paid for by the CITY.

C. Field painting of structural elements – Refer to Section 09900 Painting, for additional information.

2.5 FINISH COLOR

1. Color selections shall be chosen to match the adjacent existing MBR metal building structure. Provide color samples for review by the CITY.

PART 3 EXECUTION

3.1 GENERAL

A. Erect framing in accordance with MBMA Metal Building Systems Manual, Common Industry Practices.

B. CONTRACTOR shall use templates for accurate setting of anchor bolts. Verify location prior to placement of concrete.

C. Erect building frame true, level and plumb with bracing properly installed. Maintain structural stability of frame during entire erection process.

D. Ream holes requiring enlargement to admit bolts. Burned holes for bolted connections are not permitted.

E. Tighten all bolts/nuts in accordance with ASTM A325 or A490, as applicable.

F. The erector shall provide temporary guys and bracing where needed for squaring, plumbing and securing the structural framing against all postulated construction loads. Temporary guys, bracing, falseworks and cribbing shall be removed by the erector immediately upon completion of the work.

G. Field cutting or modifying structural members is not permitted without written authorization of the metal building manufacturer and approval of the ENGINEER.

H. Erector shall prime all welds, abrasions, and surfaces not primed or that require touch-up.

3.2 FABRICATION

A. All shop connections shall be welded in conformance with ANSI/AWS D1.1. Welders and welding operators shall be certified.

B. All field connections of primary structural members shall be bolted with high strength bolt assemblies conforming to ASTM A325 and shall be fully tightened, unless otherwise specified. Secondary structural members shall be field bolted with bolt assemblies conforming to ASTM A307 or A325, as required by design.

C. All structural-framing members that are not galvanized shall be given a shop coat of primer.

3.3 PRIMARY STRUCTURAL MEMBERS

A. Rigid frame, sidewall columns, rafter beams and canopy beams shall be shop-welded, built-up "I" shapes or tube steel shapes. Members shall be of constant depth or tapered, having base plates, necessary clips and splice plates for completely field-bolted assembly and attachment to secondary members.

B. Rafter beams and end wall columns shall be built-up "I" shapes, tube shapes, "WF" shapes, or roll-formed "C" sections as required to satisfy load and span design requirements.

3.4 SECONDARY STRUCTURAL MEMBERS

A. Purlins and girts shall be roll-formed "Z" or "C" sections, of adequate size and thickness as determined by design. Purlins and girts may be either simple span or continuous.

B. Purlins for "long-bay" building layouts shall consist of bar-joists designed in accordance with Steel Joist Institute Specifications.

C. Eave struts shall be roll-formed or brake-formed "C" sections.

D. Additional structural members at penetrations and openings shall be roll-formed or brake-formed “C” and/or “L” sections

3.5 WALL PANEL SYSTEM

A. As specified in Section 07415 and herein.

1. Provide wall panels that are one-piece in sections shown in Drawings.

2. Provide top and bottom closures and bottom supports.

3. Secure with fasteners that assure maximum weathertightness, proper bearing surface and permanent seal at point of fastening.

4. Use washers capable of assuring water-tightness at fastening locations.

B. Wall panels shall be installed by the metal building erector.

3.6 ROOF SYSTEM

A. As specified in Section 07415 and herein.

1. Panel Splicing: Panels may be spliced with minimum end overlap of 6-inches at purlins.

2. Ridge Panel: Provide factory formed ridge panel to match roof slope, of same material as roof panel, and capable of completely sealing roof ridge.

3. Secure with fasteners that assure maximum weathertightness, proper bearing surface and permanent seal at point of fastening.

4. Use washers capable of assuring water-tightness at fastening locations.

5. Expansion of Roof Panels: Provide means to allow expansion of roof panels.

B. CONTRACTOR shall coordinate with metal building system manufacturer to ensure that selected roof system is consistent with the roof system of the adjacent metal building structures on site.

C. Roof system shall be installed by the metal building erector.

3.7 GUTTERS, DOWNSPOUTS AND HANGERS

A. Provide 4-inch gutters, downspouts and hangers as indicated on the Drawings.

3.8 INSTALLATION

A. Install metal building system in accordance with manufacturer's published recommendations, specifications and shop/erection drawings.

B. Installation shall be secure, true and plumb.

C. All components and parts shall be clearly marked and erection drawings shall be supplied for identification and assembly of the parts.

D. Coordinate size, location and details of all penetrations with the Drawings, other trades and details of approved equipment. Pipe and conduit openings in roof deck and/or wall siding shall be reinforced according to manufacturer’s recommendations.

3.9 FIELD CUTTING

A. Field cutting or mitering wall and/or roof panels, erector shall use non-abrasive cutting tools such as nibblers or tin-snips. Abrasive cutting tools such as mechanical grinders, saws, shears, or scissors can damage the coating (e.g., Galvalume®) or painted finish and are not permitted.

B. Panels damaged, in the opinion of the ENGINEER, shall be replaced by the CONTRACTOR at no additional expense to the CITY.

C. Openings greater than 8-inches and less than 18-inches in greatest dimension shall be reinforced with a minimum 24-inch by 24-inch flat plate, minimum 16-gauge thickness, centered on the opening, welded to roof deck or siding.

D. Provide appropriate flashing and weather proofing around all wall and roof openings and penetrations.

3.10 FIELD QUALITY CONTROL

A. General – Installation of metal building system will be subject to Special Inspection provided by the City and evaluation during construction, as specified herein.

3.11 DEFECTIVE WORK

A. Work found to be defective, missing or damaged, in the opinion of the ENGINEER, shall immediately be replaced with proper work. Such replaced work and the inspection for same shall be at the expense of the metal building system erector.

B. Straightening of any material, if necessary, shall be done by a process and in a manner that not injure the materials, and which is approved by the ENGINEER. Sharp kinks or bends shall be cause for rejection. Heating will not be allowed.

C. Delamination and other rolling defects in structural shapes and plates shall be cause for rejection when, in the opinion of the ENGINEER, repairs are not feasible or acceptable.

D. If defects or damaged work cannot be corrected in the field, the materials shall be returned to the shop or new parts furnished, as the ENGINEER directs; the metal building system erector shall replace all work at his/her own expense.

3.12 FIELD CORRECTIONS

A. Field Painting:

1. Prepare and touch up abraded or corroded spots on shop-primed coated surface immediately after erection.

2. Use the same material as was used for the shop coat.

3. Paint shop-primed ferrous surfaces as specified in Section 09960.

B. Field Coat:

1. Prepare and apply coating as specified in Section 09960.

2. Paint primed surfaces of doors and windows as specified in Section 09960.

3. Touch-up factory finished surfaces of roof and wall panels with the manufacturer's recommended paint where damaged or abraded.

4. Where shop processes such as shearing or punching leave edges of galvanized steel unprotected by galvanization, touch-up unprotected edges as specified in this Section.

5. Repair damaged galvanized surfaces in accordance with ASTM A780.

3.13 PROTECTION

A. Protect metal building system from damage due to work of adjacent trades.

3.14 CLEANING

A. Roof surfaces shall be cleaned daily during construction of all filings, cuttings, screws, pencil markings and debris to prevent damage due to oxidation of foreign materials.

B. Metal Building Erector shall thoroughly clean all panels, trim, and gutters of all foreign materials prior to final acceptance.

END OF SECTION

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SECTION 13400 – COMMON WORK RESULTS PROCESS INSTRUMENTATION AND CONTROLS

PART 1 GENERAL

1.1 DESCRIPTION

A. A single Process Control System Integrator (PCSI) shall furnish all services and equipment for the City of Brentwood (City), Wastewater Treatment Plant Expansion Project (Project) including control panels, Programmable Logic Controller (PLC) systems, Human Machine Interface (HMI) and Supervisory Control and Data acquisition (SCADA) components, communication networks, telemetry components, and project field instrumentation.

B. The Contract Documents are a single integrated document, and as such all Divisions and Sections and Drawings apply. It is the responsibility of the Contractor and Subcontractors to review the complete set of Contract Documents to ensure a complete and coordinated project.

C. Provide equipment, hardware, software, programming and configuration of the project Programmable Logic Controllers (PLCs), Remote Telemetry Units (RTUs), Operator Interface Terminals (OITs), and central Supervisory Control and Data Acquisition (SCADA) components.

D. Equipment shall be fabricated, assembled, installed, and placed in proper operating condition in full conformity with the Contract Documents and Drawings, engineering data, instructions, and recommendations of the equipment manufacturer as approved by Engineer.

E. The work shall include furnishing, installing, and testing the equipment and materials detailed in the following Specification Sections:

1. 13400 – Process Instrumentation and Control – General Provisions
2. 13420 – Control Panels and Hardware
3. 13421 – Programmable Logic Controllers and Computer Control Systems
4. 13422 – Local Area Network Systems
5. 13430 – Field Instrument Index
6. 13431 – Instrumentation and Controls – Analytical Devices
7. 13432 – Instrumentation and Controls – Flow Devices
8. 13433 – Instrumentation and Controls – Level Devices
9. 13434 – Instrumentation and Controls – Pressure Devices
10. 13435 – Instrumentation and Controls – Temperature Devices

11. 13482 – Process Control Descriptions

12. 13490 – Commissioning of Process Control Systems

F. Where differences exist between the specific equipment Specification Sections of Division 13 and this general equipment Specification Section, the specific equipment Specifications shall govern.

1.2 SCOPE OF WORK

A. General

1. SCADA system project work will be performed at the City of Brentwood Wastewater Treatment Plant (WWTP): New PLC Control Panels, local OIT, field instrumentation, HMI equipment, control and communication network equipment, fiber optic cables, and ancillary devices.

2. Work shall include expansion and/or integration of the existing Schneider Electric/Modicon based control system to accommodate the new process systems and control equipment provided under this Contract.

B. The PCSI work shall include the following:

1. Provide all materials, equipment, labor, and services required to achieve a fully integrated and operational SCADA system. The PCSI shall design and coordinate the instrument and process control system for proper operation with related equipment and materials furnished under other Sections of these Specifications and with related existing equipment.

2. Provide all field instrumentation, sensors, analyzers, and devices as shown and as specified for monitoring and control functions as specified in Section 13482.

3. Provide auxiliary and accessory devices necessary for system operation or performance, such as transducers or relays to interface with existing equipment or equipment provided under other Sections of these Specifications whether they are specifically shown on the Drawings or not.

4. Facilitate, coordinate, and take full responsibility for integration of equipment resident on the control system network that are provided under other Sections of these Contract Documents including but not limited to:

a. Geared Single Stage Centrifugal Blower Packages (Section 11502)

b. Biosolids Dryer System (Section 11600)

c. Aeration Control System (Section 13550)

d. Screw Conveyors – Modifications and Improvements (Section 14552)

e. Standby Diesel Engine Driven Generators (Section 16230)

f. Low Voltage Adjustable Speed Drive Motor Controllers (Section 16260)

g. Static Uninterruptible Power Supplies (UPS) (Section 16263)

h. Low Voltage Reduced Voltage Solid State Starters (Section 16265)

i. Electrical Power Monitoring System (Section 16290)

j. Medium Voltage Switchgear (Section 16350)

k. 480 Volt Switchgear (Section 16436)

l. Motor Control Centers (Section 16442)

5. Facilitate, coordinate, and take full responsibility for integration of equipment monitored on standalone Modbus RTU serial connections (based on the first named manufacturer listed in the indicated Sections). Refer to the Drawings for I/O monitoring if alternative equipment is provided:

a. Submersible Compact Mixers (Section 11205)

b. Submersible Low Speed Mixers (Section 11206)

C. Follow the equipment, instrument, and loop numbering scheme that has been developed in the Contract Documents. The PCSI shall not deviate from or modify this numbering scheme without Engineer's approval.

D. Furnish and install all control system hardware specified under this contract. Complete all final wiring installation and terminations of field devices into PLC control cabinets and perform factory and field testing of all devices.

E. The City's SCADA system is based on the Schneider Electric/Modicon M580 and M340 hardware and UnityPRO software platform. The City has developed standardized blocks of PLC code, referred to as "Defined Function Blocks" (DFBs), and HMI graphics to provide SCADA uniformity at all facilities, minimize system development effort, and simplify operator training. The collection of DFBs and their associated graphics have been developed using Schneider Electric UnityPRO PLC programming software and Inductive Automation, Ignition application package. These DFBs shall be used as the basis for the new system programming at the WWTP without exception. The City control system standards information shall be provided to the PCSI at the first Control System Coordination Workshop.

F. Provide final integration and implementation of the new control elements in to the existing system. Provide installation, testing, and commissioning of the final integrated system that shall include both existing Engineer developed control logic elements. Final integration of newly developed and modified control logic elements into the existing WWTP SCADA system shall be performed by the PCSI and witnessed by the Engineer without exception.

G. Provide PLC, I/O, and OIT components that match the function, manufacturer, and series of the PLC, I/O, and OIT components provided for the Blowers (Section 11502), Biosolids Dryer (Section 11600), and Conveyors (Section 11601). The PLC systems that are provided for this project, as shown on the Network Diagrams included in the Drawings, shall be by the same manufacturer, and use common modules and system components. Firmware and module series for all PLC components shall match such that components provided by the PCSI are interchangeable with control components provided by the other packaged process system suppliers.

H. Provide PLC configuration and programming, Human Machine Interface (HMI) configuration, database development, graphic screens, communication links, and other tasks tor all new process controls provided under this Contract as specified in Section 13482. Coordinate all development work with the City and Engineer to ensure that the PLC and HMI development matches the existing controls approach and City standards. Existing PLC programming structure, standard programming defined function logic blocks, HMI screens, and operator interfaces shall be used as templates for matching look and feel to the greatest extent possible.

I. Human Machine Interface hardware, portions of the PLC hardware, and elements of the HMI and PLC software control logic are existing. Modify the existing PLC and HMI hardware, control logic, and graphic systems to incorporate the new and revised process control elements provided under this Contract. Provide new and revised PLC programming and HMI configuration including development of control programs, database configuration, graphic screens, communication links, historical archiving, and other programming tasks as specified herein. Coordinate all programs with City Controls Engineers to ensure that the HMI development, PLC programs, communications links, databases and other SCADA elements match the existing City approach and standards.

J. Existing City PLC control logic files, HMI application including screens and operator interfaces, historian databases, and other City standards shall be provided to the Contractor after Notice To Proceed. Existing programing scheme shall be used as templates for matching logic development, program structure, and HMI look and feel to the greatest extent possible.

K. All work shall be coordinated with the facility operating personnel to minimize impact on operations at the WWTP.

L. Control system programming and configuration shall include:

1. Real-time process control, including proportional integral derivative control action, individual equipment start and stop sequencing, process calculations, etc. as shown on the Contract Documents.

2. Process control functions including PID, calculations, sequencing, timing, etc., in the PLC controllers. The HMI software shall perform acquisition for the real-time database, graphic screens, set point modification, data archiving, etc. No real-time process control shall be implemented at the HMIs.

3. Collection and storage of historical operating information for present and future reporting and maintenance uses.

4. Communicating off-normal operating conditions and equipment failures.

5. Accumulating and storing equipment running times and other parameters for use in preventative maintenance.

6. Color graphic displays and reports for use by the system operating and supervisory personnel.

7. Trending for all analog values.

8. Control system and component diagnostics.

9. Manual control (by keyboard entry and mouse type pointing device) as well as view the status of pumps, valves, etc. (i.e., On-Off, Open-Close, setpoint value, etc.) from the HMI.

M. Related Work

1. Control System Network Diagram is included in the Drawings

2. Piping and Instrumentation Diagrams (P&IDs) are included in the Drawings

3. Appendix 13400-A: Control System Existing Input/Output (I/O) List. The I/O List is included for reference only. The determination of the exact number and type of I/O points shall be the responsibility of the PCSI based on the P&ID Drawings, auxiliary device requirements, and spare requirements as shown on the Drawings and specified herein.

4. Appendix 13400-B: Control System Existing Input/Output (I/O) List. The I/O List is included for reference only.

5. Appendix 13430-A: Field Instrument List. The Instrument List is included for reference only. Only major instruments are included in the Instrument List and miscellaneous switches, relays, and auxiliary devices are not included. Providing all instruments and devices necessary for the a fully functioning system shall be the responsibility of the PCSI based on the P&ID Drawings, auxiliary device requirements, and spare requirements as shown on the Drawings and specified herein.

N. Work Performed by Others

1. The City will perform the following work that is not part of this Contract.

a. Furnishing City SCADA system standards to the PCSI for use with PCSI development of modified and new SCADA programs and applications.

b. Assignment of all control system network addresses implemented by the PCSI.

1.3 SUBMITTALS

A. General

1. Shop drawings shall be submitted as specified in Section 01340. They shall be complete; giving equipment specifications, details of connections, wiring, ranges, installation requirements, and specific dimensions. Submittals consisting of only general sales literature will not be acceptable.

2. Check shop drawings for accuracy and contract requirements prior to submittal. Shop drawings shall be stamped with the date checked and a statement indicating that the shop drawings conform to Specifications and Drawings. This statement shall also list all exceptions to the Specifications and Drawings. Shop drawings not so checked and noted shall be returned marked “REJECTED – RESUBMIT”.

3. Engineer's review of submittals shall be for conformance with the design concept of the project and compliance with the Specifications and Drawings. Errors and omissions on approved shop drawings shall not relieve the Contractor from the responsibility of providing materials and workmanship required by the Specifications and Drawings.

4. Field verify all dimensions at the Project site and coordinate with the work of all other trades and work being performed by the City.

5. Shop drawings shall fully demonstrate that the equipment and services to be furnished comply with the provisions of these Specifications and shall provide a true and complete record of the equipment as manufactured and delivered.

B. Submittal Requirements

1. Submittals shall be submitted electronically or as hard copies.

   a. Hardcopy submittals shall be bound in separate three-ring binders, with a table of contents and section and subsection dividers. All drawings provided in 11-inch by 17-inch format individually "Z" folded within the binder.

   b. Electronic submittals shall be in PDF format, with PDF bookmarks matching the document table of contents and section/subsection cross references to match the equivalent hardcopy submittal structure. Scanned drawings shall be incorporated in 11-inch by 17-inch format.

2. Submittal drawings' title block shall include, as a minimum, the PCSI's registered business name and address, project name, drawing name, revision level, and personnel responsible for the content of the drawing.

3. Separate submittals shall be made for:

   a. Project Plan, Deviation List, and Schedule

   b. PLC and OIT Supplier Coordination Certification

   c. Coordination Workshops Agendas

   d. Field Instrumentation

   e. SCADA Hardware Submittal

   f. SCADA Software and Programming Submittal

   g. Control Panel Submittal

   h. Electrical Interconnection Diagrams

   i. Testing Plan

   j. Training Plan

   k. Spares, Expendables, and Test Equipment

C. Project Plan, Deviation List, and Schedule

1. The PCSI Project Plan shall be submitted and favorably reviewed before any further submittals will be accepted. Project Plan shall, at a minimum, contain the following:

   a. Overview of the proposed control system in clear text format describing the PCSI's understanding of the project work, system architecture drawing, interfaces to other systems, schedule, startup, and coordination.

   b. Approach describing how the PCSI intends to execute the work written in clear text format. Approach shall include a discussion of procurement, fabrication, testing, installation, switchover, startup, replacement of existing equipment with new, interim operations, etc. as applicable for this Project.

   c. Preliminary software and hardware submittal information solely to determine initial compliance with the requirements of the Contract Documents prior to the PCSI development of system layouts. Favorable review of software and hardware systems as part of this Project Plan stage shall not relieve the PCSI of meeting all the functional and performance requirements of the system as specified herein.

   d. Method for coordination of the software development with City standards and existing platforms including communication addressing; database structure and formats; HMI/OIT screen development approach and method for matching system Look-and Feel; PLC coding; access method for third party device data streams (e.g., Ethernet Modbus TCP, Modbus).

   e. Method for inter-platform exchange of data with description of memory mapping and block data transfer techniques. Data exchange shall address all network protocols identified on the Drawings and/or proposed by the Contractor for use under this Contract.

   f. Project personnel and organization including the PCSI project manager, project engineer, and lead project technicians. Include resumes of each key individual including the registered engineer in responsible charge for the project. Submit confirmation in writing the commitment to this project for all key staff.

   g. Preliminary Control System Coordination Workshop Agendas

   h. Preliminary testing plans

   i. Preliminary training plan

   j. Specific information needed from the City for program development including any requests for standards, programming module usage, node addresses, network protocol etc.

2. Exceptions to the Specifications or Drawings shall be clearly defined by the PCSI in a separate Deviation List. The Deviation List shall consist of a paragraph by paragraph review of the related Division 13 Specifications indicating conformance or any proposed deviations, the reason for exception, the exact nature of the exception and the proposed substitution so that a proper evaluation may be made by Engineer. The acceptability of any device or methodology submitted as an “or equal’ or “exception” to the specifications shall be at the sole discretion of Engineer.

3. Project schedule shall be prepared and submitted using Microsoft Project scheduling software or similar. Schedule shall be prepared in Gantt chart format clearly showing all major tasks, task dates and durations, milestone dates, linkages between tasks, and identification of critical path elements. At a minimum, the project schedule included in the project work plan for the control system work specified in Division 13 shall include:

    a. Demonstration of coordination with the overall project plan provided by the General Contractor under Section 01310.

    b. All subsequent control system project submittals. Include in the scheduled time durations the time required for PCSI submittal preparation and submittal review. Include provision for a minimum of two complete review cycles.

    c. Proposed dates for all project Coordination Workshops.

    d. Hardware purchasing, fabrication, and assembly (following approval of related submittals)

    e. Software purchasing (following approval of related submittals)

    f. Shipment of all field instrumentation and control system equipment

    g. Installation of all field instrumentation and control system equipment including timing and sequence for implementation of Panel 13 logic and permissive replacement with new MCP.

    h. Testing: Schedule for all testing including at a minimum the testing sequence as specified under Part 3. Testing schedule shall include submittal of test procedures a minimum of 30 days prior to commencement of testing. Schedule shall also include submittal of completed test procedure forms for review and approval by Engineer and City prior to shipment, startup, or subsequent project work.

    i. Schedule for system cutover, startup, and/or going on-line for each major system. At a minimum include the schedule for each process controller and HMI servers/workstations provided under this Contract.

    j. Schedule for all training including submittal and approval of O&M manuals, factory training, and site training.

    k. Submittal of Certification of Installation

    l. Warranty and extended warranty period as applicable

4. PLC and OIT Supplier Coordination Certification: The PCSI shall submit certification that the PLC and OIT components to be provided by the PCSI are the same manufacturer and series as the PLC and OIT components that are to be provided by the Dryer System Supplier (Section 11600) and Blower/Aeration System supplier (Section 11502 and Section 13550). The submittal shall include a complete list of PLC and OIT components that are to be supplied with each system, including power supplies, processors, communications modules, and I/O modules. No additional submittals will be reviewed until this submittal is submitted and favorably reviewed.

D. Field Instrumentation

1. Submit complete documentation of all field instruments using ISA-S20 data sheet formats. Submit a complete Bill of Materials (BOM) or Index that lists all instrumentation equipment ordered by the loop numbering system as shown in the Contract Documents.

2. Submit separate data sheets for each instrument including:

a. Plant or Site equipment number and ISA tag number.

b. Product (item) name used herein and on the Contract Drawings.

c. Manufacturer's complete model number.

d. Location of the device.

e. Input - Output characteristics (wiring, voltage, current ratings, etc.).

f. Range, size, and graduations in engineering units.

g. Physical size with dimensions, enclosure NEMA classification and mounting details in sufficient detail to determine compliance with the requirements of the Contract Documents.

h. Materials of construction for enclosure and wetted parts.

i. Instrument or control device sizing calculations where applicable.

j. Certified calibration data for all flow metering devices.

k. Two-wire or four-wire device type as applicable.

l. Submit index and data sheets in electronic format as well as hard copies/PDFs on 8-1/2” x 11” formats. Electronic format shall be in Microsoft Excel or Word.

E. SCADA Hardware Submittal

1. Catalog cuts and descriptive literature for programmable logic controllers (PLC), including central processing units, memory, input modules, output modules, modems or communication interfaces, network interface modules, mounting racks, and power supplies. Submit system bill of materials and descriptive literature for each hardware component that fully describes the units being provided.

2. Any deviations of the hardware systems from the preliminary hardware submittal included in the Project Plan shall be described in detail.

3. Catalog cuts and descriptive literature for HMI computers, HMI software, OITs, peripherals, and power supplies. Submit system bill of materials and descriptive literature for each hardware and software component, which fully describes the items being provided.

4. Complete system Input/Output (I/O) list for equipment connected to the control system under this Contract. The I/O list shall be submitted in both a Microsoft Excel readable electronic file format on a CD and an 8-1/2 inch by 11-inch hard copy. The I/O list shall include I/O name (or spare), type, physical location, point address, functional description (text that includes signal source, control function, etc.), range (Engineering units) and equivalent analog to digital “count” conversion, alarm limits (low-low, low, high, high-high, etc.), relay normal status contact configuration (i.e. relay logical condition for a normally open contact state or normally closed contact state). Both hard I/O and network/fieldbus datastream I/O shall be included. The I/O list shall be sorted in order by:

    a. Physical location: Panel, Rack, PLC CPU Name, or PLC Remote I/O Drop

    b. Source interface: Hardwired I/O; Network transfer (Ethernet/Modbus TCP, Modbus, or other network transfer protocol where specified)

    c. I/O Type: AI, AO, DI, DO etc.

    d. Complete Loop Number

    e. I/O source device tag

5. All PLC rack layouts showing rack size, module location, module type, interconnection wiring or network cables, and network connections to other network resident devices.

6. PLC Power supply calculations confirming specified sizing criteria.

7. Complete network diagram showing the inter-connections between major hardware components, media type between components, raceway requirements (conduit, wireway, etc.), raceway identification, network protocol used at each network level, and all hardware components showing the interconnection of all modules, interface devices, modems, and plug-in circuit boards. Submit comprehensive network diagram for all protocols as specified under 13422.

8. Network hardware including network switches, routers, hubs, power supplies, and rack mounting hardware.

9. A list of all hardware electrical and environmental characteristics and requirements. Submit planning information, site preparation instructions, grounding and bonding procedures, cabling diagrams, plug identifications, safety precautions or guards, and equipment layouts to enable the Contractor to proceed with the detailed site preparation for all equipment.

F. SCADA Software and Programming Submittal

1. Where new software is specified to be provided, submit details of the PLC, OIT, and/or HMI application packages to be used. Indicate all standard and optional features provided. Include copies of license agreements indicating assignment of licenses to the City.

2. Any deviation of the software platforms from the preliminary software submittal included in the Project Plan shall be described in detail.

3. Submit annotated P&IDs presenting the proposed logic and interlock relationships between PLC, motor controllers, and process elements for the logic development by the PCSI per Section 13482.

4. Submit software logic and documentation for the ladder logic program used for the application engineering effort. Documentation and programming approach shall match existing City programming format to the greatest extent possible. At a minimum, each program module, subroutine, or function block shall be fully described in a program overview that defines the scanned inputs, scanned outputs, definition of constants and variables, and function of the routine. The program overview shall be stored as a separate word processing file for inclusion in the O&M manuals.

5. Program documentation shall be comprehensive and include clear descriptions for all program elements (rungs, networks, subroutines, command descriptions, etc.) with abundant comments to clearly identify function and intent. For example, for ladder logic, the link between “coil” and “contact” shall be clearly presented (i.e. clear cross-reference between a coil and all instances of the associated contacts for that coil), the function of each timer described, the purpose of each subroutine call labeled and defined, etc.

6. Program documentation shall be sufficiently clear to allow determination of compliance with the process control requirements included in the Process Control Loop Descriptions included in Section 13482 and the Drawings. The software submittal shall demonstrate that all logic provided under this project follows the same structure and format and reflects a common programming approach.

7. Submit details of control system communication. Submit hardware and software configuration information in sufficient detail to verify performance of the wired and/or wireless communication systems as detailed herein and on the Drawings. Include details of any necessary expansion boards, special interface requirements (e.g., cables, jacks, etc.), description of drivers and impact of drivers on controller memory configuration. Any specific communication block memory addresses shall be defined.

8. Submit details of the data transfer implementation for exchanging data between the third party packaged PLC platforms, smart motor control equipment, facility HMIs, power monitoring, and other networked equipment as specified. Provide any specific programming requirements of the City’s central SCADA platforms to implement the data transfer. Indicate addressing and block transfer schemes conforming to City requirements for all data exchanges. Develop data transfer implementation for real-time process control data and on-demand condition data that does not require real-time data but rather uses a longer term scheduled data delivery scheme per Section 13482.

9. PLC Modbus TCP/Ethernet Network

   a. Network shall be used to monitor plant PLCs and third party, packaged PLC systems as specified in Sections 11500, 11600, 13550, 14552, and at other locations as specified. PLC to PLC communication requirements shall be as specified under Section 13482.

   b. Submit register maps for PLC variables. Map shall include all variables and default/polled Ethernet input, output and diagnostic bits for devices on the PLC network. All variable addressing shall conform to City Ethernet standards requirements.

   c. Submit physical originating I/O location for each data variable including equipment name (e.g., PLC name and location), I/O origination module details (e.g., main rack, expansion I/O, etc.), I/O channel, network address, and variable specification.

10. Equipment Monitoring Modbus TCP/Ethernet Network

   a. Network shall monitor equipment and components through the PLC hardware and as specified in Sections 16260, 16263, 16265, 16290, 16350, 16436, and 16422. Monitoring such non-real time variables shall be as specified under Section 13482.

   b. Submit memory maps for equipment variables. Map shall include all variables and default/polled inputs, outputs, and diagnostic data for devices on the equipment monitoring network. All variable addressing shall conform to City Ethernet standards requirements.

   c. Submit physical originating I/O location for each data variable including equipment name (e.g., MCC name and bucket ID), I/O origination module details (e.g., starter, ASD, expansion I/O, etc.), I/O channel, network address, and variable specification.

11. Submit memory usage reports for each PLC. Reports shall be in spreadsheet format and indicate both used and unused memory. Include constant and variable memory assignment records that tabulate area, location, number, and description of each numeric constant and variable. Total memory used for variables, logic, and all other data stored in PLC memory shall be tabulated and the total used and spare memory indicated to confirm the specified memory requirements.

12. Submit programming details where matching existing City standard schemes, methods, and logic for each PLC programmed including process control logic and internal housekeeping programs and routines including redundancy, heartbeat, clock synchronization, value scaling, alarm handling, etc.

13. Submit cross reference index of I/O allocation, controller memory address, HMI graphic systems address, and HMI graphic screen and/or script where the I/O point will appear. Every physical I/O point as well as calculated or virtual I/O required for the implementation of the process scheme or as required for equipment assessment shall be included. Submit electronic version of the table in Microsoft Excel format.

14. Submit final drafts of logs, reports, trends, and process graphic displays. The specifics of what shall appear on each display and report and what calculations are required to support them shall be described. Final drafts shall reflect the system requirements as specified herein as well as the result of the Coordination Workshops with the City and Engineer.

G. Control Panel Submittal: Submittals and drawings shall be furnished for all panels, consoles, and equipment enclosures specified in Section 13420. Panel assembly and elevation drawings shall be drawn to scale and detail all equipment in or on the panel. As a minimum, the panel drawings shall include the following:

1. Interior and exterior panel elevation drawings to scale.

2. Panel total weight including all components.

3. Nameplate schedule.

4. Conduit access locations for top or bottom entry.

5. Panel construction details.

6. Cabinet assembly and layout drawings to scale. The assembly drawing shall include a comprehensive bill of material on the drawing with each panel component clearly defined. The bill of material shall be cross-referenced to the assembly drawing so that a non-technical person can readily identify any component of the assembly by manufacturer and model number.

7. Fabrication and painting specifications including color (or color samples).

8. Panel control schematics and interconnection diagrams detailing the electrical connections of all equipment in and on the panel. Diagrams shall include at a minimum power and signal connections; UPS, critical (battery), and non-critical (normal) power sources; all panel ancillary equipment; protective devices; wiring and wire numbers; and terminal blocks and numbering.

9. Control panel component catalog data and cut sheets for all control panel equipment provided.

10. AC and DC load calculations for each panel supplied indicating conformance with proper sizing of incoming panel circuits, and DC power supplies. Load calculations shall include a minimum 50% spare capacity, or spare capacity as indicated in the specification requirements for the individual components.

11. Heating and cooling calculations for each panel supplied indicating conformance with cooling requirements of the supplied equipment and environmental conditions. Calculations shall include the recommended type of equipment required for both heating and cooling that will ensure maintaining the integrity of the NEMA panel rating.

12. Submit evidence that all control panels shall be constructed in conformance with UL 508 and bear the UL label confirming the construction. Specify if UL compliance and seal application shall be accomplished at the fabrication location or by field inspection by UL inspectors. All costs associated with obtaining the UL label and any inspections shall be borne by the Contractor and included in the Project Bid Price.

13. Submit anchorage calculations to comply with seismic requirements as specified in Section 01612.

H. Electrical Interconnection Diagrams

1. Electrical Interconnection Diagrams: Provide electrical interconnection diagrams depicting wiring between control panels and external devices. Sample interconnection diagrams showing expected format and level of details are included in the Drawings for reference.

   a. Interconnection diagrams shall show all termination points, field devices, motors, electrical equipment, instrumentation, terminal block numbers, device tag names, descriptions, wire colors, wire tags, wire sizes, wire routing, conduits, junction boxes, pull boxes, and hand holes, and shall be organized by loop number. All components for any loop shall be shown on the same drawing, or on consecutive sheets where a single drawing does not have sufficient space. Where multiple loops share a common conduit, those loops may be shown on the same interconnection diagram.

   b. Field device wiring shall include the device ISA tag and City loop number as shown on the Drawings along with a unique numeric identifier consisting of the originating control panel, terminal block, and terminal number where the wire lands with an additional alpha suffix if required to ensure uniqueness. For example:

      PLC-2-TB3-422 / LIT-1202-A+

   c. Control panel to control panel wiring shall include the source control panel, terminal block, and terminal number followed by destination control panel, terminal block, and terminal number with an additional alpha suffix if required to ensure uniqueness; For example:

      PLC-2-TB2-119 / CP-2202-TB1-35

   d. Field wiring for analog points will include wire labels for all associated signal conductors. Wire labels on shield, drain, and grounding conductors are not required.

   e. All field wiring shall include conduit routing on the diagram.

   f. Two-wire and four-wire equipment shall be clearly identified and power sources noted.

   g. All panel and field wiring shall be tagged and indicated on the electrical interconnection diagram. Submit final wire numbering scheme for approval by City. Complete all terminal block identification and terminal block numbers.

h. Provide electrical interconnection diagrams under this Contract for all new and existing field devices that require termination in the field by the electrical contractor. Interconnection diagrams are not required for the internal wiring of skid mounted packaged systems that are shipped to the job site pre-wired and fully assembled.

i. Include all fuse and protection devices including ratings.

j. Coordinate electrical schematics I/O wiring diagrams with internal panel wiring diagrams as specified herein.

k. Submit final circuit and cable labeling scheme for review and approval by the City prior to development of panel fabrication, connection, and schematic drawings.

I. Testing and Commissioning

1. Testing requirements shall be as specified per Section 13490

J. Training Plan

1. Training Plan Submittal: Upon receipt of Engineer's comments on the preliminary training plan included in the Project Plan, submit a final training plan. Training method and coverage shall be in conformance with the system training as specified herein. The training plan shall include:

a. Definitions of each course.

b. Specific course attendance.

c. Schedule of training courses including dates, duration, and locations of each class.

d. Resumes of the instructors who will actually implement the plan.

K. Spares, Expendables, and Test Equipment Submittal

1. Submit for each Subsystem:

a. A list of, and descriptive literature for, spares, expendables, and test equipment to be provided under this Contract as required by the related technical Specification Sections of Division 13.

b. A separate list of, and descriptive literature for, additional spares, expendables and test equipment recommended by the PCSI.

c. Storage instructions for all spare parts.

1.4 REFERENCE STANDARDS

A. Publications are referred to in the text by basic designation only. Where a date is given for reference standards, that edition shall be used. Where no date is given for reference standards, the latest edition in effect at the time of bid opening shall apply.

B. American Society for Testing and Materials (ASTM).

1. ASTM A269 – Standard Specification for Seamless and Welded Austenitic Stainless Steel Tubing for General Service.

C. American National Standards Institute (ANSI)

1. ANSI X3.5 – Flowchart Symbols and Their Usage in Information Processing

D. International Electrotechnical Commission (IES)

1. IEC 61131 - 3 – International Standards, Programmable Controllers - Part 3 Programming Languages

E. Institute of Electrical and Electronic Engineers (IEEE)

1. IEEE Standard C2 – National Electrical Safety Code (NESC)

2. IEEE Standard 472 – Electrical Surge Protection

3. IEEE Standard 802.X – LAN/MAN Standards

F. Electronic Industries Alliance (EIA)

1. EIA Standard RS-232-C – Interface between data terminal equipment and data communication equipment employing serial binary data interchange.

2. EIA Standard RS-422-A – Electrical characteristics of balanced voltage digital interface circuits

G. Instrumentation, Systems, and Automation Society (ISA)

1. ISA S5.2 – Binary Logic Diagrams for Process Operations

2. ISA S5.3 – Graphic Symbols for Distributed Control/Shared Display Instrumentation Logic and Computer Systems.

3. ISA S5.4 – Instrument Loop Diagrams

4. ISA S20 – Specification Forms for Process Measurement and Control Instruments, Primary Elements and Control Valves.

5. ISA RP60.3 – Human Engineering for Control Centers

6. ISA RP60.6 – Nameplates, Labels, and Tags for Control Centers

H. National Fire Protection Agency (NFPA)

1. NFPA 70 – National Electrical Code.

I. National Electrical Manufacturers Associations (NEMA)

1. NEMA ICS6 – Enclosures for Industrial Controls and Systems

J. Underwriters Laboratories, Inc. (UL)

1. UL 508 – Industrial Control Equipment

1.5 QUALITY ASSURANCE

A. The PCSI shall be Tesco Controls, Inc. Sacramento, California (916-395-8800)

B. Actual installation of the instrumentation system need not be performed by the PCSI's employees; however, the PCSI as a minimum shall be responsible for the technical supervision of the installation by providing on site supervision to the installers of the various components.

C. The PCSI shall furnish equipment that is the product of one manufacturer to the maximum practical extent. Where this is not practical, all equipment of a given type shall be the product of one manufacturer.

1.6 DELIVERY, STORAGE AND HANDLING

A. Shipping Precautions

1. After completion of shop assembly, factory test and approval of all equipment, cabinets, panels and consoles shall be packed in protective crates and enclosed in heavy duty polyethylene envelopes or secured sheeting to provide complete protection from damage, dust and moisture. Dehumidifiers shall be placed inside the polyethylene coverings. The equipment shall then be skid-mounted for final transport. Lifting rings shall be provided for moving enclosures without removing protective covering. Boxed weights shall be shown on shipping tags together with instructions for unloading, transporting, storing and handling at the job site.

2. Special instructions for proper field handling, storage and installation required by the manufacturer for proper protection, shall be securely attached to the packaging for each piece of equipment prior to shipment. The instructions shall be stored in resealable plastic bags or other acceptable means of protection.

3. None of the HMI control and monitoring equipment shall be shipped to the site until the designated control room and/or process areas are environmentally stable and suitable for the equipment. The Contractor and PCSI shall accept the equipment on delivery and supervise unloading within the control room areas.

4. All equipment furnished under related Specification Sections of Division 13 shall be shipped to the job site via dedicated air ride van.

B. Identification During Shipping and Storage

1. Each component shall be tagged to identify its location, tag number and function in the system. Identification shall be prominently displayed on the outside of the package.

C. Storage

1. Equipment shall not be stored out-of-doors. Equipment shall be stored in dry permanent shelters including in-line equipment and shall be adequately protected against mechanical damage. Equipment stored in untreated spaces shall have condensation space heaters installed to prevent moisture condensing on or within the equipment. Provide suitable power source for space heaters as required.

2. If any apparatus has been damaged, such damage shall be repaired by the PCSI at his/her own cost and expense. If any apparatus has been subject to possible injury by water, it shall be thoroughly dried out and put through such tests as directed by Engineer. This shall be at the cost and expense of the PCSI, or the apparatus shall be replaced by the PCSI at no additional cost.

1.7 PROJECT/SITE REQUIREMENTS

A. Elevation: Equipment shall be designed to operate at a ground elevation of approximately 75 feet above mean sea level.

B. Temperature:

1. Equipment located in exterior locations shall be suitable for operation at temperatures from +12° to +45° C degrees ambient.

2. Equipment located in internal areas shall be suitable for operation:

a. In conditioned spaces from +15° to +30° C degrees ambient.

b. In unconditioned spaces from +15° to +45° C degrees ambient

3. Were applicable, equipment shall be rated for extended storage temperatures ranges from +12° to +45° C degrees ambient.

C. Relative Humidity: Equipment located in non-environmentally controlled areas shall be suitable for 0 to 100 percent relative, condensing humidity unless noted otherwise.

D. Power Supply: 120 volts AC sources of electrical power supply shall be from unregulated industrial panel boards (either utility or standby generator) and a separate UPS power source as indicated on the Drawings.

1.8 MAINTENANCE

A. Test Equipment

1. Additional test equipment as defined in the related technical Specification Sections of Division 13.

B. Spare Parts

1. Provide spare parts of the type and quantity as specified herein and as specified in the related technical specifications of Division 13.

2. All spare parts shall be carefully packed in cartons, labeled with indelible markings, and shall be adequately treated for a long period of storage. Complete ordering information including manufacturer's part number, part ordering information including manufacturer, part number, part name, and equipment name and number(s) for which the part is to be used shall be supplied with the required spare parts. The spare parts shall be delivered and stored in a location directed by City.

1.9 WARRANTY

A. Warranty period shall be as defined in Section 01740.

B. Provide software updates and installations throughout the warranty period. Provide latest official released versions for all software provided under this Contract. The City shall have the latest software releases at the end of the warranty period. However, only software releases approved for use by the City shall be installed on the City systems, and installation shall only be made upon specific written approval by the City.

1.10 COORDINATION WORKSHOPS

A. The PCSI shall schedule and hold ten mandatory control system Coordination Workshops during the Project. The Coordination Workshops shall include as a minimum the City, the Engineer, the Contractor, the PCSI's Project engineer, and electrical subcontractor. City staff shall include construction managers, technicians, operators, and maintenance staff as required. The City shall determine which staff members will attend each workshop. Workshops shall all be held at the project site: City of Brentwood WWTP.

B. Schedule the Coordination Workshops a minimum of two weeks prior to the workshop date and include a draft agenda at the time of the request for review. Within one week subsequent to each workshop, submit draft workshop minutes for review and comment; submit final minutes incorporating any comments as necessary. The PCSI shall be responsible for facilitating the workshop and providing presentation material to all participants. The PCSI and Contractor shall document the proceedings of the Coordination Workshops and submit along with all materials used at the workshop.

C. Workshops

1. Overall System Workshop: Within 30 days of award of contract or issuance of Notice–to-Proceed or as part of the Project construction kick-off meeting, the PCSI shall lead and facilitate a half a day workshop. The intent of this workshop is to review and discuss the main items of the project and highlight key issues including but not limited to:

a. Request and coordinate receipt of City SCADA programming standards documentation, HMI application, and PLC logic UnityPRO files.

b. Describe how the system is expected to operate. Provide copies of the control system architecture and P&IDS for use in describing the SCADA system elements, programs, and operational issues. Include discussion of the main processes, control strategies, flows, pressures, temperatures etc.

c. Describe all major mechanical, electrical and I&C equipment for the system. Point out any anticipated long-lead time items.

d. Describe the submittal review, RFI & change order processes with specified turn-around times.

2. Electrical, I&C and Mechanical Workshop: A minimum of two weeks prior to any submittals being sent in for review PCSI shall lead and facilitate a 4-hour workshop to review the preliminary Electrical, I&C and Mechanical submittals & schedules. The preliminary submittals should include the following:

   a. Identify all equipment and instrumentation along with manufacturer & part/model numbers for each of the items.

   b. Identify any long lead items with submittals that need to be prepared expeditiously.

   c. Review overall Contractor's schedule and identify how the PCSI schedule submitted under the project workplan specified herein has been integrated into it. As specified, the PCSI schedule shall include all major milestones including submittals, field fabrication, testing, installation, field testing & training.

   d. Review how the PCSI will phase the installation of the control panels and associated devices into the system.

   e. Review the status of coordination with other PLC and control panel suppliers.

   f. In addition, PCSI shall request and coordinate receipt of any updated City SCADA programming standards documentation, HMI application, and PLC logic UnityPRO files to ensure development work is performed on current versions to facilitate future software integration.

3. SCADA system programming workshop: A minimum of two weeks prior to any programming work lead and facilitate in a 4-hour workshop that will be used to present the proposed PCSI programming approach and convey information to the PCSI about the Owner standards for controller programming, communications, and other configuration performed under this Contract. PCSI shall present a summary of all new and modified control and monitoring elements included under this Contract. The following items would be covered as a minimum:

   a. Programming details

      1) Present sample draft HMI screens

      2) Present samples of screen navigation and the use of pop-up windows.

      3) Present tagging conventions to be used in HMI & PLC programs.

      4) Present method for data exchange including blocks of registers to be used for data transfers from PLC-to-PLC, PLC-to-HMI, RIO to PLC, third party digital platforms, etc.

      5) Present flow or logic diagrams for PLC programming.

6) Present P&IDs showing logic and interlock relationships per the sample diagram included in Appendix 13400-E.

7) Present a list of new screens and reports to be developed under this Contract. Present a list of existing Owner screens and reports that will be modified under this Contract indicating the nature of the modifications to be implemented.

8) Present proposed documentation for PLC programming including functional rung or flow chart documentation, page documentation, segment documentation, etc. all as specified herein.

9) Present proposed documentation for HMI programming documentation including database addressing, scripts, report development, etc. all as specified herein.

10) Present proposed method for implementing acquisition of Ethernet delivered data, graphical presentation of this data on the HMI screens, historical logging of this data, and forwarding of this data to the Owner central SCADA.

11) Present programming scheme for replication of Panel 13 logic and permissives for the interim and final system including interconnection points to existing control panel relays and new I/O for new control panels.

b. The PCSI shall use the P&IDs and Control Descriptions in Section 13482 to demonstrate their understanding of and methods for the system programming.

c. In addition, PCSI shall request and coordinate receipt of any updated City SCADA programming standards documentation, HMI application, and PLC logic UnityPRO files to ensure development work is performed on current versions to facilitate future software integration.

4. Interim Project Update Workshop: During the control panel assembly and prior to scheduling of the Witness Test, PCSI shall conduct a 4-hour workshop. The intent of this workshop is for the PCSI to present project progress and highlight any significant changes in the approach. PCSI shall present:

a. A recap of how the system is expected to operate – include main flows, pressures, temperatures etc. using an updated process flow diagram.

b. Reviews of any changes to the Contract Documents of equipment, process, or services either in form or function.

c. In addition, PCSI shall request and coordinate receipt of any updated City SCADA programming standards documentation, HMI application, and PLC logic UnityPRO files to ensure development work is performed on current versions to facilitate future software integration.

5. Project On-Site Testing, Training, Startup & Commissioning Workshop: Following successful completion of the PCSI Factory Testing but prior to startup of the main control panel and first set of pump control panels, PCSI shall conduct a 4-hour workshop. The intent of this workshop is for the PCSI and Contractor to provide a review of the project schedule and project execution regarding testing, startup, and training as follows:

    a. On Site Testing: Summarize the schedule for each stage of field testing and identify the teams that will be responsible for the testing. The PCSI and Contractor shall prepare a summary of how all the testing will be performed, documented, and submitted. Draft test forms as specified herein shall be presented at the workshop.

    b. Training: The PCSI and Contractor shall provide a listing of all the scheduled training that will take place with anticipated dates in accordance with these Specifications. The PCSI and Contractor shall also prepare a summary of personnel and qualifications of the individuals responsible for the training. Also indicate the target audience for the training. Any off-site training should be coordinated with the City staff at least 30 days prior to training.

    c. Startup: The PCSI and Contractor shall coordinate startup and integrate into the startup plan, the City modifications at the WWTP. The PCSI and Contractor shall provide the draft startup plan including schedule for the startup and the personnel responsible for the startup. The plan shall be reviewed by and coordinated with the City operations, technical, and engineering staff to accommodate City operational requirements. The PCSI and Contractor shall be responsible for the preparation of all documentation that will be used for the startup testing and verification as specified herein.

    d. Commissioning: Contractor shall review the Commissioning plan and provide status of required deliverables including but not limited to:

        1) O & M's

        2) Spare Parts

        3) Warranties

        4) Service Agreements

        5) Special equipment and tools

    e. In addition, PCSI shall request and coordinate receipt of any updated City SCADA programming standards documentation, HMI application, and PLC logic UnityPRO files to ensure development work is performed on current versions to facilitate future software integration.

6. As required workshops: Five additional workshops shall be included for this project over and above the five workshops defined above.

    a. Topics and scheduling of these additional workshops shall be solely at the discretion of the Owner to address additional project requirements that may arise during construction.

b. Attendance at the additional workshops shall include at a minimum the Contractor, electrical subcontractor, PCSI, and Owner representatives.

c. Duration of each workshop shall be determined by the topic and discussion points but assume each additional workshop shall be 8 hours in length.

d. Specific personnel required for the workshops shall be determined based on the workshop topics to be addressed.

e. Owner shall provide a minimum of 2 weeks' notice to the PCSI of the need for the workshop after which the PCSI shall prepare a workshop agenda, coordinate workshop schedule, and facilitate the workshop.

1.11 FINAL SYSTEM DOCUMENTATION

A. Submit operation and maintenance manuals covering instruction and maintenance on each type of equipment in accordance with the General Conditions.

B. The instructions shall be bound in three-ring binders with drawings reduced or folded for inclusion and shall provide at least the following as a minimum.

1. A comprehensive index.

2. A complete "As Built" set of the PCSI approved hardware, software, and panel fabrication shop drawings.

3. A complete list and data sheets of the equipment supplied, including serial numbers, ranges and pertinent data.

4. Full specifications on each item.

5. System schematic drawings "As Built" and "As-Left" details illustrating all components and final condition of each.

6. Detailed service, maintenance and operation instructions for each item supplied.

7. Special maintenance requirements particular to these systems shall be clearly defined, along with special calibration and test procedures.

8. The operation instructions shall also incorporate a functional description of the entire system, with references to the systems schematic drawings and instructions.

9. Complete parts lists with stock numbers and name, address and telephone number of the local Supplier.

C. The PCSI's final documentation shall be new documentation written specifically for this project, but may include standard and modified standard documentation. Modifications to existing hardware or software manuals shall be made on the respective pages or inserted adjacent to the modified pages. All standard documentation furnished shall have all portions that apply clearly indicated. All portions that do not apply shall be lined out.

D. The manuals shall contain all illustrations, detailed drawings, electrical schematics and instructions necessary for installing, operating and maintaining the equipment. The illustrated parts shall be numbered for identification. All information contained therein shall apply specifically to the equipment furnished and shall only include instructions that are applicable. All such figures shall be formatted within the printing of the page to form a legible, durable, and permanent reference book.

E. Submit original software CD-ROMs, or data packs of all software provided under this Contract. Submit original paper based or electronic documentation of all software provided. Submit license agreement information including serial numbers, license agreements, User Registration Numbers, etc. All software provided under this Contract shall be licensed to the City.

F. The requirements for the PCSI's final documentation are as follows:

1. As built documentation shall include information from submittals, as described in this Specification, updated to reflect the as-built system. Any errors in or modifications to the system resulting from the Factory and/or Functional Acceptance Tests shall be incorporated in this documentation.

2. The Hardware Maintenance Documentation shall describe the detailed preventive and corrective procedures required to keep the system in good operating condition. Within the complete Hardware Maintenance Documentation, all hardware maintenance manuals shall refer to appropriate diagnostics, where applicable, and all necessary timing diagrams shall be included. A maintenance manual or a set of manuals shall be furnished for all delivered hardware, including peripherals. The Hardware Maintenance Documentation shall include, as a minimum, the following information:

a. Operation Information - include a detailed description of how the equipment operates and a block diagram illustrating each major assembly in the equipment.

b. Preventative-Maintenance Instructions – These instructions shall include all applicable visual examinations, hardware testing and diagnostic routines and the adjustments necessary for periodic preventive maintenance of the System.

c. Corrective-Maintenance Instructions – Include guides for locating malfunctions down to the card-replacement level. These guides shall include adequate details for quickly and efficiently locating the cause of an equipment malfunction and shall state the probable source(s) of trouble, the symptoms, probable cause and instructions for remedying the malfunction.

d. Parts Information – Include the identification of each replaceable or field-repairable module. All parts shall be identified on a list in a drawing; the identification shall be of a level of detail sufficient for procuring any repairable or replaceable part. Cross-references between the PCSI's part number and manufacturer's part numbers shall be provided.

e. Manufacturer’s contact information including name, local representative, phone numbers, web sites, and e-mail contact information.

1.12 CODES, INSPECTION AND FEES

A. Equipment, materials and installation shall comply with the requirements of the local authority having jurisdiction.

B. Obtain all necessary permits and pay all fees required for permits and inspections.

PART 2 PRODUCTS

2.1 GENERAL REQUIREMENTS

A. General

1. Substitutions on functions or type of equipment specified will not be acceptable unless specifically noted. In order to insure the interchangeability of parts, the maintenance of quality, the ease of interfacing between the various subsystems and the establishment of minimums with regard to ranges and accuracy, strict compliance with the above requirements shall be maintained. In order to insure compatibility between all equipment, it shall be the responsibility of the PCSI to coordinate all interface requirements with mechanical and electrical systems and furnish any signal isolation devices that might be required.

2. To facilitate the City's future operation and maintenance, products shall be of the same major instrumentation manufacturer, with panel mounted devices of the same type and model as far as possible.

3. PLCs, RTUs, and OITs and associated components provided for this project by the various system suppliers shall be of the same manufacturer and series. The PCSI shall coordinate with other system suppliers to ensure that firmware versions and programming software versions utilized are identical for all systems.

B. Physical

1. All instrumentation supplied shall be of the manufacturer's latest design and shall produce or be activated by signals that are established standards for the water industry.

2. Wetted components of the instrument for each installation shall be made of materials that are abrasion-resistant and corrosion-resistant to the process (e.g. sodium hypochlorite, aluminum sulfate, etc.) as shown on the Drawings and as appropriate for the installation. The wetted components material(s) shall exhibit excellent or good abrasion and corrosion resistance to the chemical in service as rated by the material manufacturer. The final approval of material selection shall rest with the Engineer.

3. All electronic instrumentation shall be of the solid-state type and shall utilize either linear transmission signals of isolated 4 to 20 mA dc (milliampere direct current) or digital protocol where specified. However, signals between instruments within the same panel or cabinet may be 1-5V dc (volts direct current).

4. Outputs of equipment that are not of the standard signals as outlined, shall have the output immediately raised and/or converted to compatible standard signals for remote transmission. No zero based signals will be allowed.

5. Provide mounting hardware and floor stands, wall brackets, or instrument racks. Fasteners for securing control panels and enclosures to walls and floors shall be either hot-dipped galvanized after fabrication or stainless steel. Provide stainless steel fasteners only in corrosive areas rated NEMA 4X. Provide and size anchors in accordance with Section 01612 and Division 5 as required per the seismic calculations. Provide minimum size anchor of 3/8-inch.

6. All indicators shall be linear in engineering process units unless otherwise noted.

7. All transmitters shall be provided with either integral indicators or conduit mounted indicators in process units, accurate to two percent or better.

8. Electronic equipment shall be of the manufacturer's latest design, utilizing printed circuitry and suitably coated to prevent contamination by dust, moisture and fungus. Solid state components shall be conservatively rated for their purpose, to assure optimum long term performance and dependability over ambient atmosphere fluctuations and 0 to 100 percent relative humidity. The field mounted equipment and system components shall be designed for installation in dusty, humid and slightly corrosive service conditions.

9. All equipment, cabinets and devices furnished hereunder shall be heavy-duty type, designed for continuous industrial service. The system shall contain products of a single manufacturer, and shall consist of equipment models that are currently in production. All equipment provided shall be of modular construction and shall be capable of field expansion.

10. All electronic/digital equipment shall be provided with radio frequency interference protection.

11. Provide heating, cooling, dehumidifying, and filtering devices in control panel, enclosures, and cabinets as required to maintain internal ambient conditions within the most restrictive requirements of the equipment housed. Submit calculations as part of the panel fabrication submittal process verifying these requirements.

C. Electrical

1. Equipment shall be designed to operate on a 60 Hertz alternating current power source at a nominal 120 volts, plus or minus 10 percent, except where specifically noted. Where possible, all field instruments shall be 24 VDC loop fieldbus powered as specified. Regulators and power supplies required for compliance with the above shall be provided between power supply and interconnected instrument loop or fieldbus link. Where equipment requires voltage regulation, constant voltage transformers shall be supplied.

2. Materials and equipment used shall be U.L. approved wherever such approved equipment and materials are available.

3. Equipment shall be designed and constructed so that in the event of a power interruption, the equipment specified hereunder shall resume normal operation without manual resetting when power is restored unless otherwise noted.

4. All transmitter output signals shall include signal and power source isolation.

D. Nameplates

1. General: Provide nameplates as specified under 16075 and as specified below.

2. All panels and field instruments shall be supplied with suitable nameplates that identify the panel and individual devices as required.

3. Nameplates shall be as recommended by ISA Recommended Practice RP60.6.

2.2 LIGHTNING/SURGE PROTECTION

A. General – Lightning/Surge protection shall be provided to protect the electronic instrumentation system from induced surges propagating along the signal and power supply lines from lightning, utility, or the internal plant electrical distribution system. The protection systems shall be such that the protective level shall not interfere with normal operation, but shall be lower than the instrument surge withstand level. Protection shall be maintenance free and self-restoring.

B. Field Instrumentation Protection – Provide individual device protection for each field instrument mounted outside of the building or facility housing the control panel. Instruments mounted within the structure as the associated control panel shall not require surge protection. Instruments shall be housed in a suitable metallic case, properly grounded. Ground wires for all instrumentation device surge protectors shall be connected to a good earth ground. Where practical route each ground wire individually and insulated from each other. Device surge protectors shall be mounted within the instrument enclosure or a separate junction box coupled to the enclosure. Provide surge protection devices as manufactured by Phoenix Contact, Telecommunications Industries Inc.; or approved equal.

C. Control Panel Power Supply – Provide protection of all 120 VAC instrument power supply lines. Source voltage to cabinets/panels regardless of location (indoor or outdoor), shall be protected by isolation transformers and surge suppressors. Provide gas tube surge suppressors or metal oxide varisters (MOVs) located at the point where the 120V source supply enters the enclosure. Install the surge device to be in strict compliance with the manufacturer's recommendation for maximum allowable circuit length between protective device and incoming circuit. Provide signal surge suppression devices as manufactured by Phoenix Contact or approved equal.

D. Instrument 120 V Power Supply – Provide protection for 120 VAC power to all 4-wire field instruments (indoor or outdoor). Provide individual gas tube surge suppressors or metal oxide varisters (MOVs) located at the instrument end of the circuit. Provide signal surge suppression devices as manufactured by Phoenix Contact or approved equal.

E. 4-20 mA Signal Lines and Non-Fiber Based Data Highway Circuits – Provide protection on all signal and data highway circuits that leave a building or are routed external to a building. Provide gas tube surge arrestors, and Zener diode protectors. Circuit protection shall be provided at both ends of the signal or data highway lines within the control panel at one end and as close to the instruments or termination device as possible. Provide signal surge suppression devices as manufactured by Phoenix Contact or approved equal.

F. Inductive Loads – Provide interposing relays on all process controller outputs or switches rated 100 VA or less that drive solenoid, coil, or motor loads. Refer to the detailed requirements for controller output protection in the detailed technical Specifications of the related Sections of Division 13. Provide interposing relays as manufactured by Phoenix Contact or approved equal.

G. Radio Communication Equipment - To protect the radio equipment the Contractor shall provide surge protection devices mounted separately from the SCADA control panels in a separate enclosure. The enclosure shall house the grounded surge protector and include terminal block and fittings as required to mount the devices. The surge protector shall be grounded per NEC Art 810. The surge protector shall be as specified in the detailed technical Specifications. At no time shall the surge protection device be mounted inside the same enclosure as the SCADA equipment.

2.3 TUBING AND FITTINGS

A. All instrument air header takeoffs and branch connections less than 2-inches shall be 316 stainless steel.

B. All instrument shut-off valves and associated fittings shall be supplied in accordance with the piping specifications and all instrument installation details. Fittings shall be Swagelok 316 stainless steel or approved equal. Valves and manifolds shall be Whitey 316 stainless steel or approved equal.

C. All instrument tubing shall be fully annealed ASTM A269 Seamless 316 grade free of OD scratches having the following dimensional characteristics as required to fit the specific installation:

1. 1/4-inches to 1/2-inches O.D. by 0.035 wall thickness.

D. All process connections to instruments shall be annealed 1/2-inches O.D. stainless steel tubing, Type 316.

E. All tubetrack shall be supported by stainless steel and installed as per manufacturer's installation instructions.

2.4 PANEL MARKINGS

A. Each control panel shall be manufactured and assembled per the requirements of UL 508A. The complete assembly shall bear the UL label as an Industrial Control Panel as defined by UL 508A. If required for UL labeling, provide ground fault protective devices, isolation transformers, fuses and other equipment as necessary to achieve compliance with the UL standard. The Drawings do not detail all UL requirements.

B. The UL label requirements shall apply to all panels except where enclosures contain instruments mounted through the enclosure walls or doors. In this case, panel construction shall meet all requirements of UL labeling as described above, but no UL label is required. This exception applies only if UL Recognized instruments or devices for the intended purpose are not made.

2.5 APPROVALS/CERTIFICATIONS

A. Instruments for hazardous locations shall have Factory Mutual (FM) approvals and certifications as specified herein, as indicated on the Drawings, or where shown on the Instrument Schedule. The instrument shall have a stainless steel tag identifying the relevant approval or certification.

2.6 UL REQUIREMENTS (UL 508A)

A. All panel components shall be UL Listed for use in an industrial control panel assembly, and used for the specific purpose for which they are designed.

B. All components that penetrate the panel shall be UL Listed to maintain the UL Type rating of the panel (Type 12, Type 4, Type 4X, etc.). If a NEMA 1 rated device is installed in the door of a NEMA 4X panel, the panel shall be de-rated to Type 1.

C. Exhaust fans and louvers shall not be mounted on a control panel door containing operator devices.

D. Non UL-Listed components may be used in a 120VAC circuit only if fed from an isolation transformer and a GFCI receptacle.

PART 3 EXECUTION

3.1 GENERAL INSTALLATION

A. Equipment shall be installed in accordance with the manufacturer's instructions. The locations of equipment, transmitters, alarms and similar devices are diagrammatic only. Exact locations shall be as determined by the PCSI during development and fabrication of systems.

B. The drawings indicate the intent and not the precise nature of the interconnection between the individual instruments. Exact nature of the final equipment interconnections shall be as determined by the PCSI during development and fabrication of systems.

C. Where specific installation details are not specified or shown on the Drawings, installation recommendations from the equipment manufacturers or ISA shall be followed as applicable.

D. The shield on each process instrumentation cable shall be continuous from source to destination and be grounded in accordance with the manufacturer’s recommendations or as directed by the Engineer. In no case shall more than one ground point be employed for each shield.

E. Once installed, remove lifting rings from cabinets/assemblies. Permanent plugs shall be provided for the holes of the same material and color as the cabinet.

F. All work shall be executed in full accordance with codes and local rulings. Should any work be performed contrary to said rulings, ordinances and regulations, the Contractor shall bear full responsibility for such violations and assume all costs arising therefrom.

G. Unless specifically shown in the Drawings, direct reading or electrical transmitting instrumentation shall not be mounted on process piping. Instrumentation shall be mounted on instrument racks or stands as detailed on the installation detail drawings. All instrumentation connections shall be provided with shutoff and drain valves. For differential pressure transmitters, valve manifolds for calibration, testing and blowdown service shall also be provided. For slurries, chemical or corrosive fluids, diaphragm seals with flushing connections shall be provided.

H. All piping and tubing to and from field instrumentation shall be provided with necessary unions, calibrations and test tees, couplings, adaptors, and shut-off valves. Process tubing shall be installed to slope from the instrument toward process for gas measurement service and from the process toward the instrument for liquid measurement service. Provide drain/vent valves or fittings at any process tubing points where the required slopes cannot be maintained.

I. Provide local electrical shutoffs and disconnects for all 4-wire field instruments requiring 120 VAC power. Electrical disconnects shall be suitably rated disconnect switches or manual motor starters as specified under Division 16.

J. Provide all brackets, hangers, and miscellaneous metals required for mounting of equipment. Mounting hardware shall be installed in a workmanlike manner and not interfere with any other equipment.

K. The PCSI shall investigate each space in the building through which equipment must pass to reach its final location. If necessary, the PCSI shall be required to ship his/her material in sections sized to permit passing through restricted areas in the building. The PCSI shall also investigate and make any field modifications to the allocated space for each cabinet, enclosure and panel to assure proper space and access (front, rear, side).

L. The PCSI shall provide on-site service to oversee the installation, the placing and location of system components, their connections to the process equipment panels, cabinets and devices, subject to Engineer's approval. The PCSI shall certify that all field wiring for power and signal circuits are correctly done in accordance with best industry practice and provide for all necessary system grounding to insure a satisfactory functioning installation. The PCSI shall schedule and coordinate work under this Section with that of the electrical work specified under applicable Sections of Division 16.

M. Provide sunshades for equipment mounted outdoors in direct sunlight. Sunshades shall include standoffs to allow air circulation around the cabinet. Orient equipment outdoors to face to the North or as required to minimize the impact of glare on LED, LCD, or other digital readouts.

3.2 TESTING

A. Provide al testing and commissioning as specified per Section 13490

3.3 TRAINING

A. The cost of training programs to be conducted with plant personnel shall be included in the Contract price. The training and instruction shall be directly related to the system being supplied. The PCSI is responsible for training associated with the control panels, instrumentation, hardware, and software.

B. The training program shall represent a comprehensive program covering all aspects of the operation and maintenance of the system.

C. All training schedules shall be coordinated with, and at the convenience of City. The training classes shall be scheduled a minimum of 2 weeks in advance of when they are to be given. Each training class shall be conducted twice during separate weeks and at different times to allow for scheduling of shift based City personnel.

D. Proposed training material, including a detailed outline of each lesson, shall be submitted for review at least 30 days in advance of when the lesson is to be given. Submitted shall be reviewed for suitability and comment provided that shall be incorporated into the course.

E. Each listed class shall be repeated (two sessions per training class) to accommodate operations and maintenance personnel shift schedules. Separate classes shall be conducted for City's maintenance and operating personnel as specified. Training scheduling shall be at the convenience of the City.

1. Maintenance classes shall stress troubleshooting, repair, calibration, and other technical aspects PCS system. Operator classes shall stress operational theory and use of the equipment provided. Training shall occur in a classroom or onsite setting as specified. All training shall be performed at the WWTP control room following successful completion of the FAT, during the 30 – day acceptance test period.

2. Classroom Training Session 1 (4 hours):

   a. Maintenance training for PLC software configuration including logic and database development, programming standards, variable addressing, alarming, analog scaling, diagnostics, and troubleshooting. Training shall be based on implementation of the PLC logic as it relates to the Project control strategies.

   b. Maintenance training for HMI software configuration including database development, displays, alarming, analog trending, diagnostics, and troubleshooting. Training shall be based on implementation of the PLC logic as it relates to the Project control strategies.

3. Classroom Training Session 2 (4 hours):

   a. Maintenance training for communication system including system configuration, system architecture, equipment familiarization, diagnostics, and troubleshooting.

   b. Maintenance training for operational theory including control panel and HMI operational characteristics.

4. On-site (field) operational training shall be performed at the treatment plant following successful completion of the Functional Acceptance Test (FAT) and during the 30-day acceptance test period.

   a. On-site Training Introduction (8 hours):

1) Perform informal "show and tell" on-site training conducted on every shift during the startup of each new facility process area prior to the Operational Readiness Testing. Introductory training shall consist of field visits to the new equipment (PLCs, RIOs, MCCs, process equipment) where each equipment will be described in terms of control start/stop, control theory, typical status monitoring, alarming. Perform associated SCADA "show and tell" for each process area that include introduction to all associated process SCADA screen along with a description of how the process controls are intended to function.

b. On-site Training Session 1 (8 hours):

1) Operational training shall also include new field instrumentation. Perform a field walk through of all field related loop equipment on a loop-by-loop basis.

2) Address field debugging, troubleshooting, maintenance procedures and calibration procedures suitable for performance by operations staff. Examples of trouble shooting shall include tracing broken wire faults, instrumentation failure, PLC component failure, PLC software/programming debugging, and other field diagnostic tasks customary for field electricians in industrial facilities.

c. On Site Training Session 2 (16 hours):

1) Detailed hands-on instruction to the City operations personnel covering; system operations including manual and automatic operational functionality of each control panel, PLC, and HMI on a loop-by-loop basis

2) Provide detail instruction of how every control loop works within the system operation including safety interlocks, system permissives, process interlocks, and overall control.

F. The PCSI shall provide detailed manuals to supplement the training courses. The manuals shall include specific details of equipment supplied and operations specific to the project.

G. The PCSI shall make use of teaching aids, manuals, slide/video presentations, etc. Training sessions shall be recorded. Recordings shall be prepared using DVD format suitable for viewing using Microsoft Windows compatible computers. After the training services, such materials shall be delivered to the City.

END OF SECTION

APPENDIX 13400-A
PLC INPUT/OUTPUT (I/O) LIST

The I/O List is included for reference only. The determination of the exact number and type of I/O points shall be the responsibility of the PCSI based on the P&ID Drawings, auxiliary device requirements, and spare requirements as shown on the Drawings and specified herein.

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13400 APPENDIX A
IO LIST

(E) 14-CP-01
(NOTE 3)

TAG NAME	ALARM/STATUS RANGE	DESCRIPTIONS	I/O TYPE	P&ID DWGS	PANEL/RTU LOCATION	REMARKS
14_P50.Remote	REMOTE	DEWATERED SLUDGE CONVEYOR 1 IN REMOTE	DI	14-I-01	14-CP-01	Provide new I/O at Existing PLC
14_P50.Status	RUNNING	DEWATERED SLUDGE CONVEYOR 1 RUNNNING	DI	14-I-01	14-CP-01	Provide new I/O at Existing PLC
14_P50.Fail	FAIL	DEWATERED SLUDGE CONVEYOR 1 FAILURE	DI	14-I-01	14-CP-01	Provide new I/O at Existing PLC
14_P50.Estop	E-STOP	DEWATERED SLUDGE CONVEYOR 1 E-STOP	DI	14-I-01	14-CP-01	Provide new I/O at Existing PLC
14_P50.Call	START/STOP	DEWATERED SLUDGE CONVEYOR 1 CALL	DO	14-I-01	14-CP-01	Provide new I/O at Existing PLC
14_P52.Opened	OPENED	DEWATERED SLUDGE CONVEYOR 1 GATE 1 OPENED	DI	14-I-01	14-CP-01	From 14-LP-03 Provide new I/O at Existing PLC
14_P52.Closed	CLOSED	DEWATERED SLUDGE CONVEYOR 1 GATE 1 CLOSED	DI	14-I-01	14-CP-01	From 14-LP-03 Provide new I/O at Existing PLC
14_P52.Open	OPEN	DEWATERED SLUDGE CONVEYOR 1 GATE 1 SV OPEN	DO	14-I-01	14-CP-01	From 14-LP-03 Provide new I/O at Existing PLC
14_P52.Close	CLOSE	DEWATERED SLUDGE CONVEYOR 1 GATE 1 SV CLOSE	DO	14-I-01	14-CP-01	From 14-LP-03 Provide new I/O at Existing PLC
14_P52.Remote	REMOTE	DEWATERED SLUDGE CONVEYOR 1 GATE 1 L/R IN REMOTE	DI	14-I-01	14-CP-01	From 14-LP-03 Provide new I/O at Existing PLC
14_P54.Opened	OPENED	DEWATERED SLUDGE CONVEYOR 1 GATE 2 OPENED	DI	14-I-01	14-CP-01	From 14-LP-10 Provide new I/O at Existing PLC
14_P54.Closed	CLOSED	DEWATERED SLUDGE CONVEYOR 1 GATE 2 CLOSED	DI	14-I-01	14-CP-01	From 14-LP-10 Provide new I/O at Existing PLC
14_P54.Open	OPEN	DEWATERED SLUDGE CONVEYOR 1 GATE 2 SV OPEN	DO	14-I-01	14-CP-01	From 14-LP-10 Provide new I/O at Existing PLC
14_P54.Close	CLOSE	DEWATERED SLUDGE CONVEYOR 1 GATE 2 SV CLOSE	DO	14-I-01	14-CP-01	From 14-LP-10 Provide new I/O at Existing PLC
14_P54.Remote	REMOTE	DEWATERED SLUDGE CONVEYOR 1 GATE 2 L/R IN REMOTE	DI	14-I-01	14-CP-01	From 14-LP-10 Provide new I/O at Existing PLC
14_P55.Remote	REMOTE	DEWATERED SLUDGE CONVEYOR 2 IN REMOTE	DI	14-I-01	14-CP-01	Provide new I/O at Existing PLC
14_P55.Status	RUNNING	DEWATERED SLUDGE CONVEYOR 2 RUNNNING	DI	14-I-01	14-CP-01	Provide new I/O at Existing PLC
14_P55.Fail	FAIL	DEWATERED SLUDGE CONVEYOR 2 FAILURE	DI	14-I-01	14-CP-01	Provide new I/O at Existing PLC
14_P55.Estop	E-STOP	DEWATERED SLUDGE CONVEYOR 2 E-STOP	DI	14-I-01	14-CP-01	Provide new I/O at Existing PLC
14_P55.Call	START/STOP	DEWATERED SLUDGE CONVEYOR 2 CALL	DO	14-I-01	14-CP-01	Provide new I/O at Existing PLC
14_P57.Opened	OPENED	DEWATERED SLUDGE CONVEYOR 2 GATE 1 OPENED	DI	14-I-01	14-CP-01	From 14-LP-03 Provide new I/O at Existing PLC
14_P57.Closed	CLOSED	DEWATERED SLUDGE CONVEYOR 2 GATE 1 CLOSED	DI	14-I-01	14-CP-01	From 14-LP-03 Provide new I/O at Existing PLC
14_P57.Open	OPEN	DEWATERED SLUDGE CONVEYOR 2 GATE 1 SV OPEN	DO	14-I-01	14-CP-01	From 14-LP-03 Provide new I/O at Existing PLC
14_P57.Close	CLOSE	DEWATERED SLUDGE CONVEYOR 2 GATE 1 SV CLOSE	DO	14-I-01	14-CP-01	From 14-LP-03 Provide new I/O at Existing PLC
14_P57.Remote	REMOTE	DEWATERED SLUDGE CONVEYOR 2 GATE 1 L/R IN REMOTE	DI	14-I-01	14-CP-01	From 14-LP-03 Provide new I/O at Existing PLC
14_P59.Opened	OPENED	DEWATERED SLUDGE CONVEYOR 2 GATE 2 OPENED	DI	14-I-01	14-CP-01	From 14-LP-10 Provide new I/O at Existing PLC

13400 APPENDIX A
IO LIST

(E) 14-CP-01
(NOTE 3)

TAG NAME	ALARM/STATUS RANGE	DESCRIPTIONS	I/O TYPE	P&ID DWGS	PANEL/RTU LOCATION	REMARKS
14_P59.Closed	CLOSED	DEWATERED SLUDGE CONVEYOR 2 GATE 2 CLOSED	DI	14-I-01	14-CP-01	From 14-LP-10 Provide new I/O at Existing PLC
14_P59.Open	OPEN	DEWATERED SLUDGE CONVEYOR 2 GATE 2 SV OPEN	DO	14-I-01	14-CP-01	From 14-LP-10 Provide new I/O at Existing PLC
14_P59.Close	CLOSE	DEWATERED SLUDGE CONVEYOR 2 GATE 2 SV CLOSE	DO	14-I-01	14-CP-01	From 14-LP-10 Provide new I/O at Existing PLC
14_P59.Remote	REMOTE	DEWATERED SLUDGE CONVEYOR 2 GATE 2 L/R IN REMOTE	DI	14-I-01	14-CP-01	From 14-LP-10 Provide new I/O at Existing PLC
14_P60.Remote	REMOTE	DEWATERED SLUDGE CONVEYOR 3 IN REMOTE	DI	14-I-02	14-CP-01	From 14-LP-10 Provide new I/O at Existing PLC
14_P60.Status	RUNNING	DEWATERED SLUDGE CONVEYOR 3 RUNNNING	DI	14-I-02	14-CP-01	From 14-LP-10 Provide new I/O at Existing PLC
14_P60.Fail	FAIL	DEWATERED SLUDGE CONVEYOR 3 FAILURE	DI	14-I-02	14-CP-01	From 14-LP-10 Provide new I/O at Existing PLC
14_P60.Estop	E-STOP	DEWATERED SLUDGE CONVEYOR 3 E-STOP	DI	14-I-02	14-CP-01	From 14-LP-10 Provide new I/O at Existing PLC
14_P60.Call	START/STOP	DEWATERED SLUDGE CONVEYOR 3 CALL	DO	14-I-02	14-CP-01	From 14-LP-10 Provide new I/O at Existing PLC
14_P65.Remote	REMOTE	DEWATERED SLUDGE CONVEYOR 4 IN REMOTE	DI	14-I-02	14-CP-01	From 14-LP-10 Provide new I/O at Existing PLC
14_P65.Status	RUNNING	DEWATERED SLUDGE CONVEYOR 4 RUNNNING	DI	14-I-02	14-CP-01	From 14-LP-10 Provide new I/O at Existing PLC
14_P65.Fail	FAIL	DEWATERED SLUDGE CONVEYOR 4 FAILURE	DI	14-I-02	14-CP-01	From 14-LP-10 Provide new I/O at Existing PLC
14_P65.Estop	E-STOP	DEWATERED SLUDGE CONVEYOR 4 E-STOP	DI	14-I-02	14-CP-01	From 14-LP-10 Provide new I/O at Existing PLC
14_P65.Call	START/STOP	DEWATERED SLUDGE CONVEYOR 4 CALL	DO	14-I-02	14-CP-01	From 14-LP-10 Provide new I/O at Existing PLC
_.						
14_P70.OK	DRYER SETUP	DRYER SETUP CONDITIONS OK	DI	14-I-02	14-CP-01	
_.						

TOTAL I/O COUNT - AI:	**0**
DI:	**29**
DO:	**12**
AO:	**0**

NOTES

1. ONLY HARD I/O TERMINATED ON RACK I/O CARDS ARE LISTED ON THE I/O LIST.
OTHER VIRTUAL I/O TRANSMITTED OVER NETWORK LINKS OR DEVELOPED WITH INTERNAL PLC LOGIC ARE NOT SHOWN.
2. EXISTING I/O NOT INCLUDED. REFER TO EXISTING I/O LISTING
3. WORK IS INCLUDED AS PART OF SCHEDULES C, D AND E AND SHALL NOT BE PERFORMED IF THOSE SCHEDULES ARE NOT SELECTED.
REFER TO SPECIFICATION SECTION 01025 – MEASUREMENT AND PAYMENT FOR ADDITIONAL DETAIL ON BID SCHEDULES.

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IO LIST

16-CP-02

TAG NAME	ALARM/STATUS RANGE	DESCRIPTIONS	I/O TYPE	P&ID DWGS	PANEL/RTU LOCATION	REMARKS
21_E17.Remote	REMOTE	OXIDATION DITCH 1 WALL PUMP 1-1 IN REMOTE	DI	21-I-01	16-CP-02	
21_E17.Status	RUNNING	OXIDATION DITCH 1 WALL PUMP 1-1 RUNNING	DI	21-I-01	16-CP-02	
21_E17.Fail	FAIL	OXIDATION DITCH 1 WALL PUMP 1-1 FAILURE	DI	21-I-01	16-CP-02	
21_E17.HiTemp	OVERTEMP	OXIDATION DITCH 1 WALL PUMP 1-1 HIGH TEMPERATURE	DI	21-I-01	16-CP-02	
21_E17.Call	START/STOP	OXIDATION DITCH 1 WALL PUMP 1-1 CALL	DO	21-I-01	16-CP-02	
21_E18.Remote	REMOTE	OXIDATION DITCH 1 WALL PUMP 1-2 IN REMOTE	DI	21-I-01	16-CP-02	
21_E18.Status	RUNNING	OXIDATION DITCH 1 WALL PUMP 1-2 RUNNING	DI	21-I-01	16-CP-02	
21_E18.Fail	FAIL	OXIDATION DITCH 1 WALL PUMP 1-2 FAILURE	DI	21-I-01	16-CP-02	
21_E18.HiTemp	OVERTEMP	OXIDATION DITCH 1 WALL PUMP 1-2 HIGH TEMPERATURE	DI	21-I-01	16-CP-02	
21_E18.Call	START/STOP	OXIDATION DITCH 1 WALL PUMP 1-2 CALL	DO	21-I-01	16-CP-02	
21_E19.Remote	REMOTE	OXIDATION DITCH 1 MIXER 1-7 IN REMOTE	DI	21-I-01	16-CP-02	
21_E19.Status	RUNNING	OXIDATION DITCH 1 MIXER 1-7 RUNNING	DI	21-I-01	16-CP-02	
21_E19.Fail	FAIL	OXIDATION DITCH 1 MIXER 1-7 FAILURE	DI	21-I-01	16-CP-02	
21_E19.HiTemp	OVERTEMP	OXIDATION DITCH 1 MIXER 1-7 HIGH TEMPERATURE	DI	21-I-01	16-CP-02	
21_E19.Call	START/STOP	OXIDATION DITCH 1 MIXER 1-7 CALL	DO	21-I-01	16-CP-02	
22_E17.Remote	REMOTE	OXIDATION DITCH 2 WALL PUMP 2-1 IN REMOTE	DI	22-I-01	16-CP-02	
22_E17.Status	RUNNING	OXIDATION DITCH 2 WALL PUMP 2-1 RUNNING	DI	22-I-01	16-CP-02	
22_E17.Fail	FAIL	OXIDATION DITCH 2 WALL PUMP 2-1 FAILURE	DI	22-I-01	16-CP-02	
22_E17.HiTemp	OVERTEMP	OXIDATION DITCH 2 WALL PUMP 2-1 HIGH TEMPERATURE	DI	22-I-01	16-CP-02	
22_E17.Call	START/STOP	OXIDATION DITCH 2 WALL PUMP 2-1 CALL	DO	22-I-01	16-CP-02	
22_E18.Remote	REMOTE	OXIDATION DITCH 2 WALL PUMP 2-2 IN REMOTE	DI	22-I-01	16-CP-02	
22_E18.Status	RUNNING	OXIDATION DITCH 2 WALL PUMP 2-2 RUNNING	DI	22-I-01	16-CP-02	
22_E18.Fail	FAIL	OXIDATION DITCH 2 WALL PUMP 2-2 FAILURE	DI	22-I-01	16-CP-02	
22_E18.HiTemp	OVERTEMP	OXIDATION DITCH 2 WALL PUMP 2-2 HIGH TEMPERATURE	DI	22-I-01	16-CP-02	
22_E18.Call	START/STOP	OXIDATION DITCH 2 WALL PUMP 2-2 CALL	DO	22-I-01	16-CP-02	
22_E19.Remote	REMOTE	OXIDATION DITCH 2 MIXER 2-7 IN REMOTE	DI	22-I-01	16-CP-02	
22_E19.Status	RUNNING	OXIDATION DITCH 2 MIXER 2-7 RUNNING	DI	22-I-01	16-CP-02	
22_E19.Fail	FAIL	OXIDATION DITCH 2 MIXER 2-7 FAILURE	DI	22-I-01	16-CP-02	
22_E19.HiTemp	OVERTEMP	OXIDATION DITCH 2 MIXER 2-7 HIGH TEMPERATURE	DI	22-I-01	16-CP-02	
22_E19.Call	START/STOP	OXIDATION DITCH 2 MIXER 2-7 CALL	DO	22-I-01	16-CP-02	
51_N5.Remote	REMOTE	WAS STORAGE MIXING BLOWER 1 IN REMOTE	DI	51-I-01	16-CP-02	
51_N5.Status	ASD ON	WAS STORAGE MIXING BLOWER 1 ASD ON	DI	51-I-01	16-CP-02	
51_N5.Fail	FAIL	WAS STORAGE MIXING BLOWER 1 FAILURE	DI	51-I-01	16-CP-02	
51_N5.HiTemp	OVERTEMP	WAS STORAGE MIXING BLOWER 1 HIGH TEMPERATURE	DI	51-I-01	16-CP-02	
51_N5.HiPress	HIGH PRESSURE	WAS STORAGE MIXING BLOWER 1 EFFLUENT HIGH PRESSURE	DI	51-I-01	16-CP-02	
51_N5.Call	START/STOP	WAS STORAGE MIXING BLOWER 1 CALL	DO	51-I-01	16-CP-02	
51_N5.Speed	0.0 - 100.0%	WAS STORAGE MIXING BLOWER 1 SPEED FEEDBACK	AI	51-I-01	16-CP-02	
51_N5.SpeedCtl	0.0 - 100.0%	WAS STORAGE MIXING BLOWER 1 SPEED CONTROL	AO	51-I-01	16-CP-02	
51_N6.Remote	REMOTE	WAS STORAGE MIXING BLOWER 2 IN REMOTE	DI	51-I-01	16-CP-02	

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IO LIST

16-CP-02

TAG NAME	ALARM/STATUS RANGE	DESCRIPTIONS	I/O TYPE	P&ID DWGS	PANEL/RTU LOCATION	REMARKS
51_N6.Status	ASD ON	WAS STORAGE MIXING BLOWER 2 ASD ON	DI	51-I-01	16-CP-02	
51_N6.Fail	FAIL	WAS STORAGE MIXING BLOWER 2 FAILURE	DI	51-I-01	16-CP-02	
51_N6.HiTemp	OVERTEMP	WAS STORAGE MIXING BLOWER 2 HIGH TEMPERATURE	DI	51-I-01	16-CP-02	
51_N6.HiPress	HIGH PRESSURE	WAS STORAGE MIXING BLOWER 2 EFFLUENT HIGH PRESSURE	DI	51-I-01	16-CP-02	
51_N6.Call	START/STOP	WAS STORAGE MIXING BLOWER 2 CALL	DO	51-I-01	16-CP-02	
51_N6.Speed	0.0 - 100.0%	WAS STORAGE MIXING BLOWER 2 SPEED FEEDBACK	AI	51-I-01	16-CP-02	
51_N6.SpeedCtl	0.0 - 100.0%	WAS STORAGE MIXING BLOWER 2 SPEED CONTROL	AO	51-I-01	16-CP-02	

TOTAL I/O COUNT - AI:	**2**
DI:	**34**
DO:	**8**
AO:	**2**

NOTES

1. ONLY HARD I/O TERMINATED ON RACK I/O CARDS ARE LISTED ON THE I/O LIST.
OTHER VIRTUAL I/O TRANSMITTED OVER NETWORK LINKS OR DEVELOPED WITH INTERNAL PLC LOGIC ARE NOT SHOWN.

13400 APPENDIX A
IO LIST

27-CP-01

TAG NAME	ALARM/STATUS RANGE	DESCRIPTIONS	I/O TYPE	P&ID DWGS	PANEL/RTU LOCATION	REMARKS
23_E5.Remote	REMOTE	AERATION BASIN 3 WALL PUMP 3-1 IN REMOTE	DI	23-I-01	27-CP-01	
23_E5.Status	RUNNING	AERATION BASIN 3 WALL PUMP 3-1 RUNNING	DI	23-I-01	27-CP-01	
23_E5.Fail	FAIL	AERATION BASIN 3 WALL PUMP 3-1 FAILURE	DI	23-I-01	27-CP-01	
23_E5.HiTemp	OVERTEMP	AERATION BASIN 3 WALL PUMP 3-1 HIGH TEMPERATURE	DI	23-I-01	27-CP-01	
23_E5.Call	START/STOP	AERATION BASIN 3 WALL PUMP 3-1 CALL	DO	23-I-01	27-CP-01	
23_E6.Remote	REMOTE	AERATION BASIN 3 MIXER 3-5 IN REMOTE	DI	23-I-01	27-CP-01	
23_E6.Status	RUNNING	AERATION BASIN 3 MIXER 3-5 RUNNING	DI	23-I-01	27-CP-01	
23_E6.Fail	FAIL	AERATION BASIN 3 MIXER 3-5 FAILURE	DI	23-I-01	27-CP-01	
23_E6.HiTemp	OVERTEMP	AERATION BASIN 3 MIXER 3-5 HIGH TEMPERATURE	DI	23-I-01	27-CP-01	
23_E6.Call	START/STOP	AERATION BASIN 3 MIXER 3-5 CALL	DO	23-I-01	27-CP-01	
23_E10_1.DO		AERATION BASIN 3 OXIC ZONE 3E DISSOLVED OXYGEN	AI	23-I-01	27-CP-01	
23_E10_2.DO		AERATION BASIN 3 OXIC ZONE 3F DISSOLVED OXYGEN	AI	23-I-01	27-CP-01	
23_E10_3.DO		AERATION BASIN 3 OXIC ZONE 3G DISSOLVED OXYGEN	AI	23-I-01	27-CP-01	
23_E10_4.DO		AERATION BASIN 3 OXIC ZONE 3H DISSOLVED OXYGEN	AI	23-I-01	27-CP-01	
23_E10_5.NH4		AERATION BASIN 3 OXIC ZONE 3H AMMONIUM	AI	23-I-01	27-CP-01	
24_E5.Remote	REMOTE	AERATION BASIN 4 WALL PUMP 4-1 IN REMOTE	DI	24-I-01	27-CP-01	
24_E5.Status	RUNNING	AERATION BASIN 4 WALL PUMP 4-1 RUNNING	DI	24-I-01	27-CP-01	
24_E5.Fail	FAIL	AERATION BASIN 4 WALL PUMP 4-1 FAILURE	DI	24-I-01	27-CP-01	
24_E5.HiTemp	OVERTEMP	AERATION BASIN 4 WALL PUMP 4-1 HIGH TEMPERATURE	DI	24-I-01	27-CP-01	
24_E5.Call	START/STOP	AERATION BASIN 4 WALL PUMP 4-1 CALL	DO	24-I-01	27-CP-01	
24_E6.Remote	REMOTE	AERATION BASIN 4 MIXER 4-5 IN REMOTE	DI	24-I-01	27-CP-01	
24_E6.Status	RUNNING	AERATION BASIN 4 MIXER 4-5 RUNNING	DI	24-I-01	27-CP-01	
24_E6.Fail	FAIL	AERATION BASIN 4 MIXER 4-5 FAILURE	DI	24-I-01	27-CP-01	
24_E6.HiTemp	OVERTEMP	AERATION BASIN 4 MIXER 4-5 HIGH TEMPERATURE	DI	24-I-01	27-CP-01	
24_E6.Call	START/STOP	AERATION BASIN 4 MIXER 4-5 CALL	DO	24-I-01	27-CP-01	
24_E10_1.DO		AERATION BASIN 4 OXIC ZONE 4E DISSOLVED OXYGEN	AI	24-I-01	27-CP-01	
24_E10_2.DO		AERATION BASIN 4 OXIC ZONE 4F DISSOLVED OXYGEN	AI	24-I-01	27-CP-01	
24_E10_3.DO		AERATION BASIN 4 OXIC ZONE 4G DISSOLVED OXYGEN	AI	24-I-01	27-CP-01	
24_E10_4.DO		AERATION BASIN 4 OXIC ZONE 4H DISSOLVED OXYGEN	AI	24-I-01	27-CP-01	
24_E10_5.NH4		AERATION BASIN 4 OXIC ZONE 4H AMMONIUM	AI	24-I-01	27-CP-01	
27_E91.Status	RUNNING	EXHAUST FAN 27-F-01-A RUNNING	DI	I-20	27-CP-01	
27_E92.Status	RUNNING	EXHAUST FAN 27-F-02-A RUNNING	DI	I-20	27-CP-01	
27_E99_A.Status	ON INVERTER	UPS 27-UPS-D2U OPERATING ON INVERTER	DI	I-20	27-CP-01	
27_E99_B.Status	IN BYPASS	UPS 27-UPS-D2U OPERATING IN BYPASS	DI	I-20	27-CP-01	
27_E99_C.Status	ON BATTERY	UPS 27-UPS-D2U OPERATING ON BATTERY	DI	I-20	27-CP-01	
27_E99_D.Status	ON CONVERTER	UPS 27-UPS-D2U OPERATING ON CONVERTER	DI	I-20	27-CP-01	
27_E99.LoVolt	VOLTAGE	UPS 27-UPS-D2U OPERATING ON LOW VOLTAGE	DI	I-20	27-CP-01	
27_E99_A.Alarm	OVERLOAD	UPS 27-UPS-D2U OPERATING ON OVERLOAD	DI	I-20	27-CP-01	

13400 APPENDIX A
IO LIST

27-CP-01

TAG NAME	ALARM/STATUS RANGE	DESCRIPTIONS	I/O TYPE	P&ID DWGS	PANEL/RTU LOCATION	REMARKS
27_E99_B.Alarm	FAIL	UPS 27-UPS-D2U OPERATING ON MALFUNCTION	DI	I-20	27-CP-01	
		TOTAL I/O COUNT - AI:	**10**			
		DI:	**25**			
		DO:	**4**			
		AO:	**0**			

NOTES

1. ONLY HARD I/O TERMINATED ON RACK I/O CARDS ARE LISTED ON THE I/O LIST.
OTHER VIRTUAL I/O TRANSMITTED OVER NETWORK LINKS OR DEVELOPED WITH INTERNAL PLC LOGIC ARE NOT SHOWN.

13400 APPENDIX A
IO LIST

34-CP-01

TAG NAME	ALARM/STATUS RANGE	DESCRIPTIONS	I/O TYPE	P&ID DWGS	PANEL/RTU LOCATION	REMARKS
34_G1.Remote	REMOTE	SECONDARY CLARIFIER 3 IN REMOTE	DI	34-I-01	34-CP-01	
34_G1.Status	RUNNING	SECONDARY CLARIFIER 3 RUNNING	DI	34-I-01	34-CP-01	
34_G1.Fail	FAIL	SECONDARY CLARIFIER 3 FAILURE	DI	34-I-01	34-CP-01	
34_G1.HiTorque	HIGH TORQUE	SECONDARY CLARIFIER 3 HIGH TORQUE	DI	34-I-01	34-CP-01	
34_G1.HiHiTorque	HIGH HIGH TORQUE	SECONDARY CLARIFIER 3 HIGH HIGH TORQUE	DI	34-I-01	34-CP-01	
34_G1.Call	START/STOP	SECONDARY CLARIFIER 3 CALL	DO	34-I-01	34-CP-01	
34_G5.Open	OPEN	SECONDARY CLARIFIER 3 UTILITY WATER SV OPEN	DO	34-I-01	34-CP-01	
36_H2.Remote	REMOTE	RAS PUMP 5 IN REMOTE	DI	36-I-01	34-CP-01	
36_H2.Status	ASD ON	RAS PUMP 5 ASD ON	DI	36-I-01	34-CP-01	
36_H2.Fail	FAIL	RAS PUMP 5 FAILURE	DI	36-I-01	34-CP-01	
36_H2.HiTemp	OVERTEMP	RAS PUMP 5 HIGH TEMPERATURE	DI	36-I-01	34-CP-01	
36_H2.LoFlow	LOW FLOW	RAS PUMP 5 SEAL WATER LOW FLOW	DI	36-I-01	34-CP-01	
36_H2.Call	START/STOP	RAS PUMP 5 CALL	DO	36-I-01	34-CP-01	
36_H2.Speed	0.0 - 100.0%	RAS PUMP 5 SPEED FEEDBACK	AI	36-I-01	34-CP-01	
36_H2.SpeedCtl	0.0 - 100.0%	RAS PUMP 5 SPEED CONTROL	AO	36-I-01	34-CP-01	
_.						
36_H3.Remote	REMOTE	RAS PUMP 6 IN REMOTE	DI	36-I-01	34-CP-01	
36_H3.Status	ASD ON	RAS PUMP 6 ASD ON	DI	36-I-01	34-CP-01	
36_H3.Fail	FAIL	RAS PUMP 6 FAILURE	DI	36-I-01	34-CP-01	
36_H3.HiTemp	OVERTEMP	RAS PUMP 6 HIGH TEMPERATURE	DI	36-I-01	34-CP-01	
36_H3.LoFlow	LOW FLOW	RAS PUMP 6 SEAL WATER LOW FLOW	DI	36-I-01	34-CP-01	
36_H3.Call	START/STOP	RAS PUMP 6 CALL	DO	36-I-01	34-CP-01	
36_H3.Speed	0.0 - 100.0%	RAS PUMP 6 SPEED FEEDBACK	AI	36-I-01	34-CP-01	
36_H3.SpeedCtl	0.0 - 100.0%	RAS PUMP 6 SPEED CONTROL	AO	36-I-01	34-CP-01	
_.						
36_H4.Flow		RAS PUMP STATION INFLUENT FLOW	AI	36-I-01	34-CP-01	
_.						
36_H5.Remote	REMOTE	SCUM PIT MIXING BLOWER 2 IN REMOTE	DI	36-I-02	34-CP-01	
36_H5.Status	RUNNING	SCUM PIT MIXING BLOWER 2 RUNNING	DI	36-I-02	34-CP-01	
36_H5.Fail	FAIL	SCUM PIT MIXING BLOWER 2 FAILURE	DI	36-I-02	34-CP-01	
36_H5.HiTemp	OVERTEMP	SCUM PIT MIXING BLOWER 2 HIGH TEMPERATURE	DI	36-I-02	34-CP-01	
36_H5.Call	START/STOP	SCUM PIT MIXING BLOWER 2 CALL	DO	36-I-02	34-CP-01	
_.						
36_H6.HiHiLevel	HIGH HIGH LEVEL	SCUM PIT HIGH HIGH LEVEL	DI	36-I-02	34-CP-01	
36_H6.HiLevel	HIGH LEVEL	SCUM PIT HIGH LEVEL	DI	36-I-02	34-CP-01	
36_H6.LoLevel	LOW LEVEL	SCUM PIT LOW LEVEL	DI	36-I-02	34-CP-01	
36_H6.LoLoLevel	LOW LOW LEVEL	SCUM PIT LOW LOW LEVEL	DI	36-I-02	34-CP-01	
_.						
36_H7.Remote	REMOTE	SECONDARY SCUM PUMP 3 IN REMOTE	DI	36-I-02	34-CP-01	
36_H7.Status	ASD ON	SECONDARY SCUM PUMP 3 ASD ON	DI	36-I-02	34-CP-01	
36_H7.Fail	FAIL	SECONDARY SCUM PUMP 3 FAILURE	DI	36-I-02	34-CP-01	
36_H7.HiTemp	OVERTEMP	SECONDARY SCUM PUMP 3 HIGH TEMPERATURE	DI	36-I-02	34-CP-01	
36_H7.HiPress	HIGH PRESSURE	SECONDARY SCUM PUMP 3 EFFLUENT HIGH PRESSURE	DI	36-I-02	34-CP-01	
36_H7.LoFlow	LOW FLOW	SECONDARY SCUM PUMP 3 SEAL WATER LOW FLOW	DI	36-I-02	34-CP-01	
36_H7.Call	START/STOP	SECONDARY SCUM PUMP 3 CALL	DO	36-I-02	34-CP-01	
36_H7.Speed	0.0 - 100.0%	SECONDARY SCUM PUMP 3 SPEED FEEDBACK	AI	36-I-02	34-CP-01	

13400 APPENDIX A
IO LIST

34-CP-01

TAG NAME	ALARM/STATUS RANGE	DESCRIPTIONS	I/O TYPE	P&ID DWGS	PANEL/RTU LOCATION	REMARKS
36_H7.SpeedCtl	0.0 - 100.0%	SECONDARY SCUM PUMP 3 SPEED CONTROL	AO	36-I-02	34-CP-01	
_.						
36_H8.Remote	REMOTE	SECONDARY SCUM PUMP 4 IN REMOTE	DI	36-I-02	34-CP-01	
36_H8.Status	ASD ON	SECONDARY SCUM PUMP 4 ASD ON	DI	36-I-02	34-CP-01	
36_H8.Fail	FAIL	SECONDARY SCUM PUMP 4 FAILURE	DI	36-I-02	34-CP-01	
36_H8.HiTemp	OVERTEMP	SECONDARY SCUM PUMP 4 HIGH TEMPERATURE	DI	36-I-02	34-CP-01	
36_H8.HiPress	HIGH PRESSURE	SECONDARY SCUM PUMP 4 EFFLUENT HIGH PRESSURE	DI	36-I-02	34-CP-01	
36_H8.LoFlow	LOW FLOW	SECONDARY SCUM PUMP 4 SEAL WATER LOW FLOW	DI	36-I-02	34-CP-01	
36_H8.Call	START/STOP	SECONDARY SCUM PUMP 4 CALL	DO	36-I-02	34-CP-01	
36_H8.Speed	0.0 - 100.0%	SECONDARY SCUM PUMP 4 SPEED FEEDBACK	AI	36-I-02	34-CP-01	
36_H8.SpeedCtl	0.0 - 100.0%	SECONDARY SCUM PUMP 4 SPEED CONTROL	AO	36-I-02	34-CP-01	
_.						
36_H11.HiHiLevel	HIGH HIGH LEVEL	RAS PUMP STATION SUMP HIGH HIGH LEVEL	DI	36-I-03	34-CP-01	
36_H11.HiLevel	HIGH LEVEL	RAS PUMP STATION SUMP HIGH LEVEL	DI	36-I-03	34-CP-01	
36_H11.LoLevel	LOW LEVEL	RAS PUMP STATION SUMP LOW LEVEL	DI	36-I-03	34-CP-01	
36_H11.LoLoLevel	LOW LOW LEVEL	RAS PUMP STATION SUMP LOW LOW LEVEL	DI	36-I-03	34-CP-01	
_.						
36_H12.Remote	REMOTE	SUMP PUMP 3 IN REMOTE	DI	36-I-03	34-CP-01	
36_H12.Status	RUNNING	SUMP PUMP 3 RUNNING	DI	36-I-03	34-CP-01	
36_H12.Fail	FAIL	SUMP PUMP 3 FAILURE	DI	36-I-03	34-CP-01	
36_H12.HiTemp	OVERTEMP	SUMP PUMP 3 HIGH TEMPERATURE	DI	36-I-03	34-CP-01	
36_H12.Leak	SEAL LEAK	SUMP PUMP 3 SEAL LEAK	DI	36-I-03	34-CP-01	
36_H12.Call	START/STOP	SUMP PUMP 3 CALL	DO	36-I-03	34-CP-01	
_.						
36_H13.Remote	REMOTE	SUMP PUMP 4 IN REMOTE	DI	36-I-03	34-CP-01	
36_H13.Status	RUNNING	SUMP PUMP 4 RUNNING	DI	36-I-03	34-CP-01	
36_H13.Fail	FAIL	SUMP PUMP 4 FAILURE	DI	36-I-03	34-CP-01	
36_H13.HiTemp	OVERTEMP	SUMP PUMP 4 HIGH TEMPERATURE	DI	36-I-03	34-CP-01	
36_H13.Leak	SEAL LEAK	SUMP PUMP 4 SEAL LEAK	DI	36-I-03	34-CP-01	
36_H13.Call	START/STOP	SUMP PUMP 4 CALL	DO	36-I-03	34-CP-01	
_.						
36_H91.Status	Running	SUPPLY FAN 36-F-01-FA, RUNNING	DI	I-20	34-CP-01	
_.						

TOTAL I/O COUNT - AI:	**5**
DI:	**50**
DO:	**9**
AO:	**4**

NOTES

1. ONLY HARD I/O TERMINATED ON RACK I/O CARDS ARE LISTED ON THE I/O LIST.
OTHER VIRTUAL I/O TRANSMITTED OVER NETWORK LINKS OR DEVELOPED WITH INTERNAL PLC LOGIC ARE NOT SHOWN.

13400 APPENDIX A
IO LIST

(E) 43-CP-01

TAG NAME	ALARM/STATUS RANGE	DESCRIPTIONS	I/O TYPE	P&ID DWGS	PANEL/RTU LOCATION	REMARKS
62_K10.CL2F		CHLORINE CONTACT BASINS INFLUENT FREE CHLORINE	AI	60-I-01	43-CP-01	Provide new I/O at Existing PLC
62_K10.HiFlow	HIGH FLOW	CHLORINE CONTACT BASINS INFLUENT SAMPLE PUMP FLOW	DI	60-I-01	43-CP-01	Provide new I/O at Existing PLC
_.						
62_K12.Remote	REMOTE	CHLORINE CONTACT BASIN 2 INFLUENT GATE IN REMOTE	DI	60-I-01	43-CP-01	Provide new I/O at Existing PLC
62_K12.Opened	OPENED	CHLORINE CONTACT BASIN 2 INFLUENT GATE OPENED	DI	60-I-01	43-CP-01	Provide new I/O at Existing PLC
62_K12.Closed	CLOSED	CHLORINE CONTACT BASIN 2 INFLUENT GATE CLOSED	DI	60-I-01	43-CP-01	Provide new I/O at Existing PLC
62_K12.Open	OPEN	CHLORINE CONTACT BASIN 2 INFLUENT GATE OPEN COMMAND	DO	60-I-01	43-CP-01	Provide new I/O at Existing PLC
62_K12.Close	CLOSE	CHLORINE CONTACT BASIN 2 INFLUENTGATE CLOSE COMMAND	DO	60-I-01	43-CP-01	Provide new I/O at Existing PLC
_.						
62_K14.Remote	REMOTE	CHLORINE CONTACT BASIN 2 INFLUENT GATE IN REMOTE	DI	60-I-01	43-CP-01	Provide new I/O at Existing PLC
62_K14.Opened	OPENED	CHLORINE CONTACT BASIN 2 INFLUENT GATE OPENED	DI	60-I-01	43-CP-01	Provide new I/O at Existing PLC
62_K14.Closed	CLOSED	CHLORINE CONTACT BASIN 2 INFLUENT GATE CLOSED	DI	60-I-01	43-CP-01	Provide new I/O at Existing PLC
62_K14.Open	OPEN	CHLORINE CONTACT BASIN 2 INFLUENT GATE OPEN COMMAND	DO	60-I-01	43-CP-01	Provide new I/O at Existing PLC
62_K14.Close	CLOSE	CHLORINE CONTACT BASIN 2 INFLUENTGATE CLOSE COMMAND	DO	60-I-01	43-CP-01	Provide new I/O at Existing PLC
_.						
62_K16.Remote	REMOTE	CHLORINE CONTACT BASIN 2 EFFLUENT GATE IN REMOTE	DI	60-I-01	43-CP-01	Provide new I/O at Existing PLC
62_K16.Opened	OPENED	CHLORINE CONTACT BASIN 2 EFFLUENT GATE OPENED	DI	60-I-01	43-CP-01	Provide new I/O at Existing PLC
62_K16.Closed	CLOSED	CHLORINE CONTACT BASIN 2 EFFLUENT GATE CLOSED	DI	60-I-01	43-CP-01	Provide new I/O at Existing PLC
62_K16.Open	OPEN	CHLORINE CONTACT BASIN 2 EFFLUENT GATE OPEN COMMAND	DO	60-I-01	43-CP-01	Provide new I/O at Existing PLC
62_K16.Close	CLOSE	CHLORINE CONTACT BASIN 2 EFFLUENTGATE CLOSE COMMAND	DO	60-I-01	43-CP-01	Provide new I/O at Existing PLC
_.						
62_K18.Remote	REMOTE	CHLORINE CONTACT BASIN 2 EFFLUENT GATE IN REMOTE	DI	60-I-01	43-CP-01	Provide new I/O at Existing PLC
62_K18.Opened	OPENED	CHLORINE CONTACT BASIN 2 EFFLUENT GATE OPENED	DI	60-I-01	43-CP-01	Provide new I/O at Existing PLC
62_K18.Closed	CLOSED	CHLORINE CONTACT BASIN 2 EFFLUENT GATE CLOSED	DI	60-I-01	43-CP-01	Provide new I/O at Existing PLC
62_K18.Open	OPEN	CHLORINE CONTACT BASIN 2 EFFLUENT GATE OPEN COMMAND	DO	60-I-01	43-CP-01	Provide new I/O at Existing PLC
62_K18.Close	CLOSE	CHLORINE CONTACT BASIN 2 EFFLUENTGATE CLOSE COMMAND	DO	60-I-01	43-CP-01	Provide new I/O at Existing PLC
_.						
62_K21.HiFlow	HIGH FLOW	CHLORINE CONTACT BASIN EFFLUENT SAMPLE PUMP FLOW	DI	60-I-01	43-CP-01	Provide new I/O at Existing PLC
62_K22.HiFlow	HIGH FLOW	CHLORINE CONTACT BASIN 2B EFFLUENT SAMPLE PUMP FLOW	DI	60-I-01	43-CP-01	Provide new I/O at Existing PLC
62_K23.HiFlow	HIGH FLOW	CHLORINE CONTACT BASIN 2A EFFLUENT SAMPLE PUMP FLOW	DI	60-I-01	43-CP-01	Provide new I/O at Existing PLC
_.						
61_I3.Remote	REMOTE	FILTER FEED PUMP 3 IN REMOTE	DI	61-I-01	43-CP-01	Provide new I/O at Existing PLC
61_I3.ASDOn	ASD ON	FILTER FEED PUMP 3 ASD ON	DI	61-I-01	43-CP-01	Provide new I/O at Existing PLC
61_I3.BypassOn	BYPASS ON	FILTER FEED PUMP 3 BYPASS ON	DI	61-I-01	43-CP-01	Provide new I/O at Existing PLC
61_I3.Fail	FAIL	FILTER FEED PUMP 3 FAILURE	DI	61-I-01	43-CP-01	Provide new I/O at Existing PLC
61_I3.HiTemp	OVERTEMP	FILTER FEED PUMP 3 HIGH TEMPERATURE	DI	61-I-01	43-CP-01	Provide new I/O at Existing PLC
61_I3.Leak	SEAL LEAK	FILTER FEED PUMP 3 SEAL LEAK	DI	61-I-01	43-CP-01	Provide new I/O at Existing PLC
61_I3.ASDCall	ASD CALL	FILTER FEED PUMP 3 ASD CALL	DO	61-I-01	43-CP-01	Provide new I/O at Existing PLC
61_I3.BypassCall	BYPASS CALL	FILTER FEED PUMP 3 BYPASS CALL	DO	61-I-01	43-CP-01	Provide new I/O at Existing PLC
61_I3.Speed	0.0 - 100.0%	FILTER FEED PUMP 3 SPEED FEEDBACK	AI	61-I-01	43-CP-01	Provide new I/O at Existing PLC
61_I3.SpeedCtl	0.0 - 100.0%	FILTER FEED PUMP 3 SPEED CONTROL	AO	61-I-01	43-CP-01	Provide new I/O at Existing PLC
		TOTAL I/O COUNT - AI:	**2**			
		DI:	**22**			
		DO:	**10**			
		AO:	**1**			

NOTES

1. ONLY HARD I/O TERMINATED ON RACK I/O CARDS ARE LISTED ON THE I/O LIST.
OTHER VIRTUAL I/O TRANSMITTED OVER NETWORK LINKS OR DEVELOPED WITH INTERNAL PLC LOGIC ARE NOT SHOWN.

13400 APPENDIX A
IO LIST

(E) 43-CP-01

TAG NAME	ALARM/STATUS RANGE	DESCRIPTIONS	I/O TYPE	P&ID DWGS	PANEL/RTU LOCATION	REMARKS

2. EXISTING I/O NOT INCLUDED. REFER TO EXISTING I/O LISTING

13400 APPENDIX A
IO LIST

(E) 50-CP-01

TAG NAME	ALARM/STATUS RANGE	DESCRIPTIONS	I/O TYPE	P&ID DWGS	PANEL/RTU LOCATION	REMARKS
50_J12_1.NH4		TERTIARY FILTERS FLOW SPLITTER AMMONIUM	AI	50-I-01	50-CP-01	Provide new I/O at Existing PLC
_.						
_.						
		TOTAL I/O COUNT - AI:	**1**			
		DI:	**0**			
		DO:	**0**			
		AO:	**0**			

NOTES

1. ONLY HARD I/O TERMINATED ON RACK I/O CARDS ARE LISTED ON THE I/O LIST.
OTHER VIRTUAL I/O TRANSMITTED OVER NETWORK LINKS OR DEVELOPED WITH INTERNAL PLC LOGIC ARE NOT SHOWN.

2. EXISTING I/O NOT INCLUDED. REFER TO EXISTING I/O LISTING

13400 APPENDIX A
IO LIST

51-CP-01

TAG NAME	ALARM/STATUS RANGE	DESCRIPTIONS	I/O TYPE	P&ID DWGS	PANEL/RTU LOCATION	REMARKS
21_E10_1.DO		OXIDATION DITCH 1 OXIC ZONE 1E DISSOLVED OXYGEN	AI	21-I-01	51-CP-01	
21_E10_2.DO		OXIDATION DITCH 1 OXIC ZONE 1F DISSOLVED OXYGEN	AI	21-I-01	51-CP-01	
21_E10_3.DO		OXIDATION DITCH 1 OXIC ZONE 1G DISSOLVED OXYGEN	AI	21-I-01	51-CP-01	
21_E10_4.DO		OXIDATION DITCH 1 OXIC ZONE 1H DISSOLVED OXYGEN	AI	21-I-01	51-CP-01	
21_E10_5.NH4		OXIDATION DITCH 1 OXIC ZONE 1H AMMONIUM	AI	21-I-01	51-CP-01	
21_E20.Remote	REMOTE	OX DITCH 1 OXIC ZONE 1E AIR INFLUENT VALVE IN REMOTE	DI	21-I-02	51-CP-01	
21_E20.Opened	OPENED	OX DITCH 1 OXIC ZONE 1E AIR INFLUENT VALVE OPENED	DI	21-I-02	51-CP-01	
21_E20.Closed	CLOSED	OX DITCH 1 OXIC ZONE 1E AIR INFLUENT VALVE CLOSED	DI	21-I-02	51-CP-01	
21_E20.Position	0.0 - 100.0%	OX DITCH 1 OXIC ZONE 1E AIR INFLUENT VALVE POSITION FEEDBACK	AI	21-I-02	51-CP-01	
21_E20.PosCtl	0.0 - 100.0%	OX DITCH 1 OXIC ZONE 1E AIR INFLUENT VALVE POSITION CONTROL	AO	21-I-02	51-CP-01	
21_E20.Flow		OX DITCH 1 OXIC ZONE 1E AIR INFLUENT FLOW	AI	21-I-02	51-CP-01	
_.						
21_E21.Remote	REMOTE	OX DITCH 1 OXIC ZONE 1F AIR INFLUENT VALVE IN REMOTE	DI	21-I-02	51-CP-01	
21_E21.Opened	OPENED	OX DITCH 1 OXIC ZONE 1F AIR INFLUENT VALVE OPENED	DI	21-I-02	51-CP-01	
21_E21.Closed	CLOSED	OX DITCH 1 OXIC ZONE 1F AIR INFLUENT VALVE CLOSED	DI	21-I-02	51-CP-01	
21_E21.Position	0.0 - 100.0%	OX DITCH 1 OXIC ZONE 1F AIR INFLUENT VALVE POSITION FEEDBACK	AI	21-I-02	51-CP-01	
21_E21.PosCtl	0.0 - 100.0%	OX DITCH 1 OXIC ZONE 1F AIR INFLUENT VALVE POSITION CONTROL	AO	21-I-02	51-CP-01	
21_E21.Flow		OX DITCH 1 OXIC ZONE 1F AIR INFLUENT FLOW	AI	21-I-02	51-CP-01	
_.						
21_E22.Remote	REMOTE	OX DITCH 1 OXIC ZONE 1G AIR INFLUENT VALVE IN REMOTE	DI	21-I-02	51-CP-01	
21_E22.Opened	OPENED	OX DITCH 1 OXIC ZONE 1G AIR INFLUENT VALVE OPENED	DI	21-I-02	51-CP-01	
21_E22.Closed	CLOSED	OX DITCH 1 OXIC ZONE 1G AIR INFLUENT VALVE CLOSED	DI	21-I-02	51-CP-01	
21_E22.Position	0.0 - 100.0%	OX DITCH 1 OXIC ZONE 1G AIR INFLUENT VALVE POSITION FEEDBACK	AI	21-I-02	51-CP-01	
21_E22.PosCtl	0.0 - 100.0%	OX DITCH 1 OXIC ZONE 1G AIR INFLUENT VALVE POSITION CONTROL	AO	21-I-02	51-CP-01	
21_E22.Flow		OX DITCH 1 OXIC ZONE 1G AIR INFLUENT FLOW	AI	21-I-02	51-CP-01	
_.						
21_E23.Remote	REMOTE	OX DITCH 1 OXIC ZONE 1H AIR INFLUENT VALVE IN REMOTE	DI	21-I-02	51-CP-01	
21_E23.Opened	OPENED	OX DITCH 1 OXIC ZONE 1H AIR INFLUENT VALVE OPENED	DI	21-I-02	51-CP-01	
21_E23.Closed	CLOSED	OX DITCH 1 OXIC ZONE 1H AIR INFLUENT VALVE CLOSED	DI	21-I-02	51-CP-01	
21_E23.Position	0.0 - 100.0%	OX DITCH 1 OXIC ZONE 1H AIR INFLUENT VALVE POSITION FEEDBACK	AI	21-I-02	51-CP-01	
21_E23.PosCtl	0.0 - 100.0%	OX DITCH 1 OXIC ZONE 1H AIR INFLUENT VALVE POSITION CONTROL	AO	21-I-02	51-CP-01	
21_E23.Flow		OX DITCH 1 OXIC ZONE 1H AIR INFLUENT FLOW	AI	21-I-02	51-CP-01	
_.						
22_E10_1.DO		OXIDATION DITCH 2 OXIC ZONE 2E DISSOLVED OXYGEN	AI	22-I-01	51-CP-01	
22_E10_2.DO		OXIDATION DITCH 2 OXIC ZONE 2F DISSOLVED OXYGEN	AI	22-I-01	51-CP-01	
22_E10_3.DO		OXIDATION DITCH 2 OXIC ZONE 2G DISSOLVED OXYGEN	AI	22-I-01	51-CP-01	
22_E10_4.DO		OXIDATION DITCH 2 OXIC ZONE 2H DISSOLVED OXYGEN	AI	22-I-01	51-CP-01	
22_E10_5.NH4		OXIDATION DITCH 2 OXIC ZONE 2H AMMONIUM	AI	22-I-01	51-CP-01	
22_E20.Remote	REMOTE	OX DITCH 2 OXIC ZONE 2E AIR INFLUENT VALVE IN REMOTE	DI	22-I-02	51-CP-01	
22_E20.Opened	OPENED	OX DITCH 2 OXIC ZONE 2E AIR INFLUENT VALVE OPENED	DI	22-I-02	51-CP-01	
22_E20.Closed	CLOSED	OX DITCH 2 OXIC ZONE 2E AIR INFLUENT VALVE CLOSED	DI	22-I-02	51-CP-01	
22_E20.Position	0.0 - 100.0%	OX DITCH 2 OXIC ZONE 2E AIR INFLUENT VALVE POSITION FEEDBACK	AI	22-I-02	51-CP-01	
22_E20.PosCtl	0.0 - 100.0%	OX DITCH 2 OXIC ZONE 2E AIR INFLUENT VALVE POSITION CONTROL	AO	22-I-02	51-CP-01	
22_E20.Flow		OX DITCH 2 OXIC ZONE 2E AIR INFLUENT FLOW	AI	22-I-02	51-CP-01	

13400 APPENDIX A
IO LIST

51-CP-01

TAG NAME	ALARM/STATUS RANGE	DESCRIPTIONS	I/O TYPE	P&ID DWGS	PANEL/RTU LOCATION	REMARKS
22_E21.Remote	REMOTE	OX DITCH 2 OXIC ZONE 2F AIR INFLUENT VALVE IN REMOTE	DI	22-I-02	51-CP-01	
22_E21.Opened	OPENED	OX DITCH 2 OXIC ZONE 2F AIR INFLUENT VALVE OPENED	DI	22-I-02	51-CP-01	
22_E21.Closed	CLOSED	OX DITCH 2 OXIC ZONE 2F AIR INFLUENT VALVE CLOSED	DI	22-I-02	51-CP-01	
22_E21.Position	0.0 - 100.0%	OX DITCH 2 OXIC ZONE 2F AIR INFLUENT VALVE POSITION FEEDBACK	AI	22-I-02	51-CP-01	
22_E21.PosCtl	0.0 - 100.0%	OX DITCH 2 OXIC ZONE 2F AIR INFLUENT VALVE POSITION CONTROL	AO	22-I-02	51-CP-01	
22_E21.Flow		OX DITCH 2 OXIC ZONE 2F AIR INFLUENT FLOW	AI	22-I-02	51-CP-01	
22_E22.Remote	REMOTE	OX DITCH 2 OXIC ZONE 2G AIR INFLUENT VALVE IN REMOTE	DI	22-I-02	51-CP-01	
22_E22.Opened	OPENED	OX DITCH 2 OXIC ZONE 2G AIR INFLUENT VALVE OPENED	DI	22-I-02	51-CP-01	
22_E22.Closed	CLOSED	OX DITCH 2 OXIC ZONE 2G AIR INFLUENT VALVE CLOSED	DI	22-I-02	51-CP-01	
22_E22.Position	0.0 - 100.0%	OX DITCH 2 OXIC ZONE 2G AIR INFLUENT VALVE POSITION FEEDBACK	AI	22-I-02	51-CP-01	
22_E22.PosCtl	0.0 - 100.0%	OX DITCH 2 OXIC ZONE 2G AIR INFLUENT VALVE POSITION CONTROL	AO	22-I-02	51-CP-01	
22_E22.Flow		OX DITCH 2 OXIC ZONE 2G AIR INFLUENT FLOW	AI	22-I-02	51-CP-01	
_.						
22_E23.Remote	REMOTE	OX DITCH 2 OXIC ZONE 2H AIR INFLUENT VALVE IN REMOTE	DI	22-I-02	51-CP-01	
22_E23.Opened	OPENED	OX DITCH 2 OXIC ZONE 2H AIR INFLUENT VALVE OPENED	DI	22-I-02	51-CP-01	
22_E23.Closed	CLOSED	OX DITCH 2 OXIC ZONE 2H AIR INFLUENT VALVE CLOSED	DI	22-I-02	51-CP-01	
22_E23.Position	0.0 - 100.0%	OX DITCH 2 OXIC ZONE 2H AIR INFLUENT VALVE POSITION FEEDBACK	AI	22-I-02	51-CP-01	
22_E23.PosCtl	0.0 - 100.0%	OX DITCH 2 OXIC ZONE 2H AIR INFLUENT VALVE POSITION CONTROL	AO	22-I-02	51-CP-01	
22_E23.Flow		OX DITCH 2 OXIC ZONE 2H AIR INFLUENT FLOW	AI	22-I-02	51-CP-01	
_.						
51_N1.Flow		WAS STORAGE TANKS INFLUENT FLOW	AI	51-I-01	51-CP-01	
51_N1.Solids		WAS STORAGE TANKS INFLUENT SUSPENDED SOLIDS	AI	51-I-01	51-CP-01	
_.						
51_N2.Remote	REMOTE	WAS STORAGE TANK 1 INFLUENT VALVE IN REMOTE	DI	51-I-01	51-CP-01	
51_N2.Opened	OPENED	WAS STORAGE TANK 1 INFLUENT VALVE OPENED	DI	51-I-01	51-CP-01	
51_N2.Closed	CLOSED	WAS STORAGE TANK 1 INFLUENT VALVE CLOSED	DI	51-I-01	51-CP-01	
51_N2.Open	OPEN	WAS STORAGE TANK 1 INFLUENT VALVE OPEN COMMAND	DO	51-I-01	51-CP-01	
51_N2.Close	CLOSE	WAS STORAGE TANK 1 INFLUENT VALVE CLOSE COMMAND	DO	51-I-01	51-CP-01	
_.						
51_N3.Remote	REMOTE	WAS STORAGE TANK 2 INFLUENT VALVE IN REMOTE	DI	51-I-01	51-CP-01	
51_N3.Opened	OPENED	WAS STORAGE TANK 2 INFLUENT VALVE OPENED	DI	51-I-01	51-CP-01	
51_N3.Closed	CLOSED	WAS STORAGE TANK 2 INFLUENT VALVE CLOSED	DI	51-I-01	51-CP-01	
51_N3.Open	OPEN	WAS STORAGE TANK 2 INFLUENT VALVE OPEN COMMAND	DO	51-I-01	51-CP-01	
51_N3.Close	CLOSE	WAS STORAGE TANK 2 INFLUENT VALVE CLOSE COMMAND	DO	51-I-01	51-CP-01	
_.						
51_N4.Remote	REMOTE	WAS STORAGE TANK 3 INFLUENT VALVE IN REMOTE	DI	51-I-01	51-CP-01	
51_N4.Opened	OPENED	WAS STORAGE TANK 3 INFLUENT VALVE OPENED	DI	51-I-01	51-CP-01	
51_N4.Closed	CLOSED	WAS STORAGE TANK 3 INFLUENT VALVE CLOSED	DI	51-I-01	51-CP-01	
51_N4.Open	OPEN	WAS STORAGE TANK 3 INFLUENT VALVE OPEN COMMAND	DO	51-I-01	51-CP-01	
51_N4.Close	CLOSE	WAS STORAGE TANK 3 INFLUENT VALVE CLOSE COMMAND	DO	51-I-01	51-CP-01	
_.						
51_N7.Remote	REMOTE	WAS STORAGE TANK 1 AIR INFLUENT VALVE IN REMOTE	DI	51-I-01	51-CP-01	
51_N7.Opened	OPENED	WAS STORAGE TANK 1 AIR INFLUENT VALVE OPENED	DI	51-I-01	51-CP-01	
51_N7.Closed	CLOSED	WAS STORAGE TANK 1 AIR INFLUENT VALVE CLOSED	DI	51-I-01	51-CP-01	
51_N7.Position	0.0 - 100.0%	WAS STORAGE TANK 1 AIR INFLUENT VALVE POSITION FEEDBACK	AI	51-I-01	51-CP-01	
51_N7.PosCtl	0.0 - 100.0%	WAS STORAGE TANK 1 AIR INFLUENT VALVE POSITION CONTROL	AO	51-I-01	51-CP-01	

13400 APPENDIX A
IO LIST

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TAG NAME	ALARM/STATUS RANGE	DESCRIPTIONS	I/O TYPE	P&ID DWGS	PANEL/RTU LOCATION	REMARKS
51_N7.Flow		WAS STORAGE TANK 1 AIR INFLUENT FLOW	AI	51-I-01	51-CP-01	
_.						
51_N8.Remote	REMOTE	WAS STORAGE TANK 2 AIR INFLUENT VALVE IN REMOTE	DI	51-I-01	51-CP-01	
51_N8.Opened	OPENED	WAS STORAGE TANK 2 AIR INFLUENT VALVE OPENED	DI	51-I-01	51-CP-01	
51_N8.Closed	CLOSED	WAS STORAGE TANK 2 AIR INFLUENT VALVE CLOSED	DI	51-I-01	51-CP-01	
51_N8.Position	0.0 - 100.0%	WAS STORAGE TANK 2 AIR INFLUENT VALVE POSITION FEEDBACK	AI	51-I-01	51-CP-01	
51_N8.PosCtl	0.0 - 100.0%	WAS STORAGE TANK 2 AIR INFLUENT VALVE POSITION CONTROL	AO	51-I-01	51-CP-01	
51_N8.Flow		WAS STORAGE TANK 2 AIR INFLUENT FLOW	AI	51-I-01	51-CP-01	
_.						
51_N9.Remote	REMOTE	WAS STORAGE TANK 3 AIR INFLUENT VALVE IN REMOTE	DI	51-I-01	51-CP-01	
51_N9.Opened	OPENED	WAS STORAGE TANK 3 AIR INFLUENT VALVE OPENED	DI	51-I-01	51-CP-01	
51_N9.Closed	CLOSED	WAS STORAGE TANK 3 AIR INFLUENT VALVE CLOSED	DI	51-I-01	51-CP-01	
51_N9.Position	0.0 - 100.0%	WAS STORAGE TANK 3 AIR INFLUENT VALVE POSITION FEEDBACK	AI	51-I-01	51-CP-01	
51_N9.PosCtl	0.0 - 100.0%	WAS STORAGE TANK 3 AIR INFLUENT VALVE POSITION CONTROL	AO	51-I-01	51-CP-01	
51_N9.Flow		WAS STORAGE TANK 3 AIR INFLUENT FLOW	AI	51-I-01	51-CP-01	
_.						
51_N11.Remote	REMOTE	WAS STORAGE TANK 1 DECANT EFFLUENT VALVE IN REMOTE	DI	51-I-01	51-CP-01	
51_N11.Opened	OPENED	WAS STORAGE TANK 1 DECANT EFFLUENT VALVE OPENED	DI	51-I-01	51-CP-01	
51_N11.Closed	CLOSED	WAS STORAGE TANK 1 DECANT EFFLUENT VALVE CLOSED	DI	51-I-01	51-CP-01	
51_N11.Open	OPEN	WAS STORAGE TANK 1 DECANT EFFLUENT VALVE OPEN COMMAND	DO	51-I-01	51-CP-01	
51_N11.Close	CLOSE	WAS STORAGE TANK 1 DECANT EFFLUENT VALVE CLOSE COMMAND	DO	51-I-01	51-CP-01	
_.						
51_N12.Remote	REMOTE	WAS STORAGE TANK 1 DECANT EFFLUENT VALVE IN REMOTE	DI	51-I-01	51-CP-01	
51_N12.Opened	OPENED	WAS STORAGE TANK 1 DECANT EFFLUENT VALVE OPENED	DI	51-I-01	51-CP-01	
51_N12.Closed	CLOSED	WAS STORAGE TANK 1 DECANT EFFLUENT VALVE CLOSED	DI	51-I-01	51-CP-01	
51_N12.Open	OPEN	WAS STORAGE TANK 1 DECANT EFFLUENT VALVE OPEN COMMAND	DO	51-I-01	51-CP-01	
51_N12.Close	CLOSE	WAS STORAGE TANK 1 DECANT EFFLUENT VALVE CLOSE COMMAND	DO	51-I-01	51-CP-01	
_.						
51_N13.Remote	REMOTE	WAS STORAGE TANK 1 DECANT EFFLUENT VALVE IN REMOTE	DI	51-I-01	51-CP-01	
51_N13.Opened	OPENED	WAS STORAGE TANK 1 DECANT EFFLUENT VALVE OPENED	DI	51-I-01	51-CP-01	
51_N13.Closed	CLOSED	WAS STORAGE TANK 1 DECANT EFFLUENT VALVE CLOSED	DI	51-I-01	51-CP-01	
51_N13.Open	OPEN	WAS STORAGE TANK 1 DECANT EFFLUENT VALVE OPEN COMMAND	DO	51-I-01	51-CP-01	
51_N13.Close	CLOSE	WAS STORAGE TANK 1 DECANT EFFLUENT VALVE CLOSE COMMAND	DO	51-I-01	51-CP-01	
_.						
51_N14.Remote	REMOTE	WAS STORAGE TANK 2 DECANT EFFLUENT VALVE IN REMOTE	DI	51-I-01	51-CP-01	
51_N14.Opened	OPENED	WAS STORAGE TANK 2 DECANT EFFLUENT VALVE OPENED	DI	51-I-01	51-CP-01	
51_N14.Closed	CLOSED	WAS STORAGE TANK 2 DECANT EFFLUENT VALVE CLOSED	DI	51-I-01	51-CP-01	
51_N14.Open	OPEN	WAS STORAGE TANK 2 DECANT EFFLUENT VALVE OPEN COMMAND	DO	51-I-01	51-CP-01	
51_N14.Close	CLOSE	WAS STORAGE TANK 2 DECANT EFFLUENT VALVE CLOSE COMMAND	DO	51-I-01	51-CP-01	
_.						
51_N15.Remote	REMOTE	WAS STORAGE TANK 2 DECANT EFFLUENT VALVE IN REMOTE	DI	51-I-01	51-CP-01	
51_N15.Opened	OPENED	WAS STORAGE TANK 2 DECANT EFFLUENT VALVE OPENED	DI	51-I-01	51-CP-01	
51_N15.Closed	CLOSED	WAS STORAGE TANK 2 DECANT EFFLUENT VALVE CLOSED	DI	51-I-01	51-CP-01	
51_N15.Open	OPEN	WAS STORAGE TANK 2 DECANT EFFLUENT VALVE OPEN COMMAND	DO	51-I-01	51-CP-01	
51_N15.Close	CLOSE	WAS STORAGE TANK 2 DECANT EFFLUENT VALVE CLOSE COMMAND	DO	51-I-01	51-CP-01	
_.						
51_N16.Remote	REMOTE	WAS STORAGE TANK 2 DECANT EFFLUENT VALVE IN REMOTE	DI	51-I-01	51-CP-01	

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IO LIST

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TAG NAME	ALARM/STATUS RANGE	DESCRIPTIONS	I/O TYPE	P&ID DWGS	PANEL/RTU LOCATION	REMARKS
51_N16.Opened	OPENED	WAS STORAGE TANK 2 DECANT EFFLUENT VALVE OPENED	DI	51-I-01	51-CP-01	
51_N16.Closed	CLOSED	WAS STORAGE TANK 2 DECANT EFFLUENT VALVE CLOSED	DI	51-I-01	51-CP-01	
51_N16.Open	OPEN	WAS STORAGE TANK 2 DECANT EFFLUENT VALVE OPEN COMMAND	DO	51-I-01	51-CP-01	
51_N16.Close	CLOSE	WAS STORAGE TANK 2 DECANT EFFLUENT VALVE CLOSE COMMAND	DO	51-I-01	51-CP-01	
_.						
51_N17.Remote	REMOTE	WAS STORAGE TANK 3 DECANT EFFLUENT VALVE IN REMOTE	DI	51-I-01	51-CP-01	
51_N17.Opened	OPENED	WAS STORAGE TANK 3 DECANT EFFLUENT VALVE OPENED	DI	51-I-01	51-CP-01	
51_N17.Closed	CLOSED	WAS STORAGE TANK 3 DECANT EFFLUENT VALVE CLOSED	DI	51-I-01	51-CP-01	
51_N17.Open	OPEN	WAS STORAGE TANK 3 DECANT EFFLUENT VALVE OPEN COMMAND	DO	51-I-01	51-CP-01	
51_N17.Close	CLOSE	WAS STORAGE TANK 3 DECANT EFFLUENT VALVE CLOSE COMMAND	DO	51-I-01	51-CP-01	
_.						
51_N18.Remote	REMOTE	WAS STORAGE TANK 3 DECANT EFFLUENT VALVE IN REMOTE	DI	51-I-01	51-CP-01	
51_N18.Opened	OPENED	WAS STORAGE TANK 3 DECANT EFFLUENT VALVE OPENED	DI	51-I-01	51-CP-01	
51_N18.Closed	CLOSED	WAS STORAGE TANK 3 DECANT EFFLUENT VALVE CLOSED	DI	51-I-01	51-CP-01	
51_N18.Open	OPEN	WAS STORAGE TANK 3 DECANT EFFLUENT VALVE OPEN COMMAND	DO	51-I-01	51-CP-01	
51_N18.Close	CLOSE	WAS STORAGE TANK 3 DECANT EFFLUENT VALVE CLOSE COMMAND	DO	51-I-01	51-CP-01	
_.						
51_N19.Remote	REMOTE	WAS STORAGE TANK 3 DECANT EFFLUENT VALVE IN REMOTE	DI	51-I-01	51-CP-01	
51_N19.Opened	OPENED	WAS STORAGE TANK 3 DECANT EFFLUENT VALVE OPENED	DI	51-I-01	51-CP-01	
51_N19.Closed	CLOSED	WAS STORAGE TANK 3 DECANT EFFLUENT VALVE CLOSED	DI	51-I-01	51-CP-01	
51_N19.Open	OPEN	WAS STORAGE TANK 3 DECANT EFFLUENT VALVE OPEN COMMAND	DO	51-I-01	51-CP-01	
51_N19.Close	CLOSE	WAS STORAGE TANK 3 DECANT EFFLUENT VALVE CLOSE COMMAND	DO	51-I-01	51-CP-01	
_.						
51_N20.Remote	REMOTE	WAS STORAGE TANK 1 WAS EFFLUENT VALVE IN REMOTE	DI	51-I-01	51-CP-01	
51_N20.Opened	OPENED	WAS STORAGE TANK 1 WAS EFFLUENT VALVE OPENED	DI	51-I-01	51-CP-01	
51_N20.Closed	CLOSED	WAS STORAGE TANK 1 WAS EFFLUENT VALVE CLOSED	DI	51-I-01	51-CP-01	
51_N20.Open	OPEN	WAS STORAGE TANK 1 WAS EFFLUENT VALVE OPEN COMMAND	DO	51-I-01	51-CP-01	
51_N20.Close	CLOSE	WAS STORAGE TANK 1 WAS EFFLUENT VALVE CLOSE COMMAND	DO	51-I-01	51-CP-01	
_.						
51_N21.Remote	REMOTE	WAS STORAGE TANK 2 WAS EFFLUENT VALVE IN REMOTE	DI	51-I-01	51-CP-01	
51_N21.Opened	OPENED	WAS STORAGE TANK 2 WAS EFFLUENT VALVE OPENED	DI	51-I-01	51-CP-01	
51_N21.Closed	CLOSED	WAS STORAGE TANK 2 WAS EFFLUENT VALVE CLOSED	DI	51-I-01	51-CP-01	
51_N21.Open	OPEN	WAS STORAGE TANK 2 WAS EFFLUENT VALVE OPEN COMMAND	DO	51-I-01	51-CP-01	
51_N21.Close	CLOSE	WAS STORAGE TANK 2 WAS EFFLUENT VALVE CLOSE COMMAND	DO	51-I-01	51-CP-01	
_.						
51_N22.Remote	REMOTE	WAS STORAGE TANK 3 WAS EFFLUENT VALVE IN REMOTE	DI	51-I-01	51-CP-01	
51_N22.Opened	OPENED	WAS STORAGE TANK 3 WAS EFFLUENT VALVE OPENED	DI	51-I-01	51-CP-01	
51_N22.Closed	CLOSED	WAS STORAGE TANK 3 WAS EFFLUENT VALVE CLOSED	DI	51-I-01	51-CP-01	
51_N22.Open	OPEN	WAS STORAGE TANK 3 WAS EFFLUENT VALVE OPEN COMMAND	DO	51-I-01	51-CP-01	
51_N22.Close	CLOSE	WAS STORAGE TANK 3 WAS EFFLUENT VALVE CLOSE COMMAND	DO	51-I-01	51-CP-01	
_.						
51_N23.Remote	REMOTE	WAS STORAGE TANKS INFLUENT VALVE IN REMOTE	DI	51-I-01	51-CP-01	
51_N23.Opened	OPENED	WAS STORAGE TANKS INFLUENT VALVE OPENED	DI	51-I-01	51-CP-01	
51_N23.Closed	CLOSED	WAS STORAGE TANKS INFLUENT VALVE CLOSED	DI	51-I-01	51-CP-01	
51_N23.Position	0.0 - 100.0%	WAS STORAGE TANKS INFLUENT VALVE POSITION FEEDBACK	AI	51-I-01	51-CP-01	
51_N23.PosCtl	0.0 - 100.0%	WAS STORAGE TANKS INFLUENT VALVE POSITION CONTROL	AO	51-I-01	51-CP-01	
_.						

13400 APPENDIX A
IO LIST

51-CP-01

TAG NAME	ALARM/STATUS RANGE	DESCRIPTIONS	I/O TYPE	P&ID DWGS	PANEL/RTU LOCATION	REMARKS
51_N24.Remote	REMOTE	WAS STORAGE TANKS INFLUENT VALVE IN REMOTE	DI	51-I-01	51-CP-01	
51_N24.Opened	OPENED	WAS STORAGE TANKS INFLUENT VALVE OPENED	DI	51-I-01	51-CP-01	
51_N24.Closed	CLOSED	WAS STORAGE TANKS INFLUENT VALVE CLOSED	DI	51-I-01	51-CP-01	
51_N24.Position	0.0 - 100.0%	WAS STORAGE TANKS INFLUENT VALVE POSITION FEEDBACK	AI	51-I-01	51-CP-01	
51_N24.PosCtl	0.0 - 100.0%	WAS STORAGE TANKS INFLUENT VALVE POSITION CONTROL	AO	51-I-01	51-CP-01	
_.						
51_N25.Level		WAS STORAGE TANK 1 LEVEL	AI	51-I-01	51-CP-01	
51_N26.Level		WAS STORAGE TANK 2 LEVEL	AI	51-I-01	51-CP-01	
51_N27.Level		WAS STORAGE TANK 3 LEVEL	AI	51-I-01	51-CP-01	
_.						
51_N28.Solids		WAS STORAGE EFFLUENT SUSPENDED SOLIDS	AI	51-I-01	51-CP-01	
_.						
51_N29.Remote	REMOTE	WAS STORAGE TANKS DRAIN VALVE IN REMOTE	DI	51-I-01	51-CP-01	
51_N29.Opened	OPENED	WAS STORAGE TANKS DRAIN VALVE OPENED	DI	51-I-01	51-CP-01	
51_N29.Closed	CLOSED	WAS STORAGE TANKS DRAIN VALVE CLOSED	DI	51-I-01	51-CP-01	
51_N29.Open	OPEN	WAS STORAGE TANKS DRAIN VALVE OPEN COMMAND	DO	51-I-01	51-CP-01	
51_N29.Close	CLOSE	WAS STORAGE TANKS DRAIN VALVE CLOSE COMMAND	DO	51-I-01	51-CP-01	
_.						
_.						
_.						
_.						

TOTAL I/O COUNT - AI:	**40**
DI:	**87**
DO:	**32**
AO:	**13**

NOTES

1. ONLY HARD I/O TERMINATED ON RACK I/O CARDS ARE LISTED ON THE I/O LIST.
OTHER VIRTUAL I/O TRANSMITTED OVER NETWORK LINKS OR DEVELOPED WITH INTERNAL PLC LOGIC ARE NOT SHOWN.

13400 APPENDIX A
IO LIST

52-CP-01
(NOTE 2)

TAG NAME	ALARM/STATUS RANGE	DESCRIPTIONS	I/O TYPE	P&ID DWGS	PANEL/RTU LOCATION	REMARKS
14_P90.Status	RUNNING	FOUL AIR FAN FAN 14-F-12-FA RUNNING	DI	52-I-01	52-CP-01	
52_O91.Status	RUNNING	EXHAUST FAN 52-F-11-A RUNNING	DI	I-20	52-CP-01	
52_O92.Status	RUNNING	EXHAUST FAN 52-F-12-A RUNNING	DI	I-20	52-CP-01	
52_O93.Status	RUNNING	EXHAUST FAN 52-F-13-A RUNNING	DI	I-20	52-CP-01	
52_O94.Status	RUNNING	EXHAUST FAN 52-F-14-A RUNNING	DI	I-20	52-CP-01	
52_O95.Status	RUNNING	EXHAUST FAN 52-F-15-A RUNNING	DI	I-20	52-CP-01	
52_O99_A.Status	ON INVERTER	UPS 52-UPS-D1U OPERATING ON INVERTER	DI	I-20	52-CP-01	
52_O99_B.Status	IN BYPASS	UPS 52-UPS-D1U OPERATING IN BYPASS	DI	I-20	52-CP-01	
52_O99_C.Status	ON BATTERY	UPS 52-UPS-D1U OPERATING ON BATTERY	DI	I-20	52-CP-01	
52_O99_D.Status	ON CONVERTER	UPS 52-UPS-D1U OPERATING ON CONVERTER	DI	I-20	52-CP-01	
52_O99.LoVolt	VOLTAGE	UPS 52-UPS-D1U OPERATING ON LOW VOLTAGE	DI	I-20	52-CP-01	
52_O99_A.Alarm	OVERLOAD	UPS 52-UPS-D1U OPERATING ON OVERLOAD	DI	I-20	52-CP-01	
52_O99_B.Alarm	FAIL	UPS 52-UPS-D1U OPERATING ON MALFUNCTION	DI	I-20	52-CP-01	
_.						

TOTAL I/O COUNT - AI:	**0**
DI:	**12**
DO:	**0**
AO:	**0**

NOTES

1. ONLY HARD I/O TERMINATED ON RACK I/O CARDS ARE LISTED ON THE I/O LIST.
OTHER VIRTUAL I/O TRANSMITTED OVER NETWORK LINKS OR DEVELOPED WITH INTERNAL PLC LOGIC ARE NOT SHOWN.

2. WORK IS INCLUDED AS PART OF SCHEDULES C, D AND E AND SHALL NOT BE PERFORMED IF THOSE SCHEDULES ARE NOT SELECTED.
REFER TO SPECIFICATION SECTION 01025 – MEASUREMENT AND PAYMENT FOR ADDITIONAL DETAIL ON BID SCHEDULES.

13400 APPENDIX A
IO LIST

(E) 64-CP-01

TAG NAME	ALARM/STATUS RANGE	DESCRIPTIONS	I/O TYPE	P&ID DWGS	PANEL/RTU LOCATION	REMARKS
62_K4_2.CL2F		CHLORINE CONTACT BASINS EFFLUENT FREE CHLORINE	AI	60-I-01	64-CP-01	Provide new I/O at Existing PLC
62_K4_3.CL2F		CHLORINE CONTACT BASINS 2A/2B FREE CHLORINE	AI	60-I-01	64-CP-01	Provide new I/O at Existing PLC
_.						
_.						
		TOTAL I/O COUNT - AI:	**2**			
		DI:	**0**			
		DO:	**0**			
		AO:	**0**			

NOTES

1. ONLY HARD I/O TERMINATED ON RACK I/O CARDS ARE LISTED ON THE I/O LIST.
OTHER VIRTUAL I/O TRANSMITTED OVER NETWORK LINKS OR DEVELOPED WITH INTERNAL PLC LOGIC ARE NOT SHOWN.
2. EXISTING I/O NOT INCLUDED. REFER TO EXISTING I/O LISTING

APPENDIX 13400-B
EXISTING PLC INPUT/OUTPUT (I/O) LIST

The I/O List for existing equipment is included for reference only.

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13400 APPENDIX B
EXISTING IO LIST

14-CP-01

TAG NAME	ALARM/STATUS RANGE	DESCRIPTIONS	I/O TYPE	PANEL/RTU LOCATION	RACK	SLOT	CHANNEL	MODULE #	REMARKS
_.		UPS TROUBLE	DI	14-CP-01	3	3	0	140DAI55300	
_.		24 VDC POWER OK	DI	14-CP-01	3	3	1	140DAI55300	
_.		BELT FILTER PRESS # 1 ON	DI	14-CP-01	3	3	2	140DAI55300	
_.		BELT FILTER PRESS # 1 FAIL	DI	14-CP-01	3	3	3	140DAI55300	
_.		BELT FILTER HYDRAULIC UNIT # 1 ON	DI	14-CP-01	3	3	4	140DAI55300	
_.		BELT FILTER HYDRAULIC UNIT # 1 FAIL	DI	14-CP-01	3	3	5	140DAI55300	
_.		BELT FILTER PRESS # 1 READY	DI	14-CP-01	3	3	6	140DAI55300	
_.		BELT DRIVE SYSTEM # 1 ON	DI	14-CP-01	3	3	7	140DAI55300	
_.		BELT FILTER PRESS # 1 E-STOP	DI	14-CP-01	3	3	8	140DAI55300	
_.		BELT FILTER SLUDGE PUMP # 1 INC SPEED	DI	14-CP-01	3	3	9	140DAI55300	
_.		BELT FILTER SLUDGE PUMP # 1 DEC SPEED	DI	14-CP-01	3	3	10	140DAI55300	
_.		BELT FILTER POLYMER PUMP # 1 INC SPEED	DI	14-CP-01	3	3	11	140DAI55300	
_.		BELT FILTER POLYMER PUMP # 1 DEC SPEED	DI	14-CP-01	3	3	12	140DAI55300	
_.		BELT FILTER PRESS # 2 ON	DI	14-CP-01	3	3	13	140DAI55300	
_.		BELT FILTER PRESS # 2 FAIL	DI	14-CP-01	3	3	14	140DAI55300	
_.		BELT FILTER HYDRAULIC UNIT # 2 ON	DI	14-CP-01	3	3	15	140DAI55300	
_.		BELT FILTER HYDRAULIC UNIT # 2 FAIL	DI	14-CP-01	3	3	16	140DAI55300	
_.		BELT FILTER PRESS # 2 READY	DI	14-CP-01	3	3	17	140DAI55300	
_.		BELT DRIVE SYSTEM # 2 ON	DI	14-CP-01	3	3	18	140DAI55300	
_.		BELT FILTER PRESS # 2 E-STOP	DI	14-CP-01	3	3	19	140DAI55300	
_.		BELT FILTER SLUDGE PUMP # 2 INC SPEED	DI	14-CP-01	3	3	20	140DAI55300	
_.		BELT FILTER SLUDGE PUMP # 2 DEC SPEED	DI	14-CP-01	3	3	21	140DAI55300	
_.		BELT FILTER POLYMER PUMP # 2 INC SPEED	DI	14-CP-01	3	3	22	140DAI55300	
_.		BELT FILTER POLYMER PUMP # 2 DEC SPEED	DI	14-CP-01	3	3	23	140DAI55300	
_.		VALVE IN REMOTE	DI	14-CP-01	3	3	24	140DAI55300	
_.		LIMIT SWITCH OPEN	DI	14-CP-01	3	3	25	140DAI55300	
_.		LIMIT SWITCH CLOSED	DI	14-CP-01	3	3	26	140DAI55300	
_.		VALVE IN REMOTE	DI	14-CP-01	3	3	27	140DAI55300	
_.		LIMIT SWITCH OPEN	DI	14-CP-01	3	3	28	140DAI55300	
_.		LIMIT SWITCH CLOSED	DI	14-CP-01	3	3	29	140DAI55300	
_.		BELT PRESS FEED PUMP # 1 IN REMOTE	DI	14-CP-01	3	3	30	140DAI55300	
_.		BELT PRESS FEED PUMP # 1 PUMP ON	DI	14-CP-01	3	3	31	140DAI55300	
_.									
_.		BELT PRESS FEED PUMP # 1 FAIL	DI	14-CP-01	3	4	0	140DAI55300	
_.		BELT PRESS FEED PUMP # 1 HIGH DISCHARGE PRESSURE	DI	14-CP-01	3	4	1	140DAI55300	
_.		BELT PRESS FEED PUMP # 2 IN REMOTE	DI	14-CP-01	3	4	2	140DAI55300	
_.		BELT PRESS FEED PUMP # 2 PUMP ON	DI	14-CP-01	3	4	3	140DAI55300	
_.		BELT PRESS FEED PUMP # 2 HIGH DISCHARGE PRESSURE	DI	14-CP-01	3	4	4	140DAI55300	
_.		BELT PRESS FEED PUMP # 2 FAIL	DI	14-CP-01	3	4	5	140DAI55300	
_.		BELT PRESS FEED PUMP # 3 IN REMOTE	DI	14-CP-01	3	4	6	140DAI55300	
_.		BELT PRESS FEED PUMP # 3 PUMP ON	DI	14-CP-01	3	4	7	140DAI55300	
_.		BELT PRESS FEED PUMP # 3 FAIL	DI	14-CP-01	3	4	8	140DAI55300	
_.		BELT PRESS FEED PUMP # 3 HIGH DISCHARGE PRESSURE	DI	14-CP-01	3	4	9	140DAI55300	
_.		WASHWATER PUMP #1 IN REMOTE	DI	14-CP-01	3	4	10	140DAI55300	
_.		WASHWATER PUMP # 1 PUMP ON	DI	14-CP-01	3	4	11	140DAI55300	
_.		WASHWATER PUMP # 1 OVERLOAD	DI	14-CP-01	3	4	12	140DAI55300	
_.		WASHWATER PUMP #2 IN REMOTE	DI	14-CP-01	3	4	13	140DAI55300	
_.		WASHWATER PUMP # 2 PUMP ON	DI	14-CP-01	3	4	14	140DAI55300	
_.		WASHWATER PUMP # 2 OVERLOAD	DI	14-CP-01	3	4	15	140DAI55300	
_.		POLYMER MIX BLEND UNIT # 1 IN REMOTE	DI	14-CP-01	3	4	16	140DAI55300	
_.		POLYMER MIX BLEND UNIT # 1 RUNNING	DI	14-CP-01	3	4	17	140DAI55300	
_.		POLYMER MIX BLEND UNIT # 1 FAIL	DI	14-CP-01	3	4	18	140DAI55300	
_.		POLYMER MIX BLEND UNIT # 2 IN REMOTE	DI	14-CP-01	3	4	19	140DAI55300	
_.		POLYMER MIX BLEND UNIT # 2 RUNNING	DI	14-CP-01	3	4	20	140DAI55300	
_.		POLYMER MIX BLEND UNIT # 2 FAIL	DI	14-CP-01	3	4	21	140DAI55300	
_.		POLYMER MIX BLEND UNIT # 3 IN REMOTE	DI	14-CP-01	3	4	22	140DAI55300	
_.		POLYMER MIX BLEND UNIT # 3 RUNNING	DI	14-CP-01	3	4	23	140DAI55300	
_.		POLYMER MIX BLEND UNIT # 3 FAIL	DI	14-CP-01	3	4	24	140DAI55300	
_.		FILTRATE SUMP PUMP LEVEL HIGH HIGH "HIGH HIGH"	DI	14-CP-01	3	4	25	140DAI55300	
_.		FILTRATE SUMP PUMP LEVEL HIGH "START PUMP"	DI	14-CP-01	3	4	26	140DAI55300	
_.		FILTRATE SUMP PUMP LEVEL LOW "STOP PUMP"	DI	14-CP-01	3	4	27	140DAI55300	
_.		FILTRATE PUMP # 1 IN REMOTE	DI	14-CP-01	3	4	28	140DAI55300	
_.		FILTRATE PUMP # 1 ON	DI	14-CP-01	3	4	29	140DAI55300	

13400 APPENDIX B
EXISTING IO LIST

14-CP-01

TAG NAME	ALARM/STATUS RANGE	DESCRIPTIONS	I/O TYPE	PANEL/RTU LOCATION	RACK	SLOT	CHANNEL	MODULE #	REMARKS
_.		FILTRATE PUMP # 1 OVERLOAD	DI	14-CP-01	3	4	30	140DAI55300	
_.		FILTRATE PUMP # 2 IN REMOTE	DI	14-CP-01	3	4	31	140DAI55300	
_.									
_.		FILTRATE PUMP # 2 ON	DI	14-CP-01	3	5	0	140DAI55300	
_.		FILTRATE PUMP # 2 OVERLOAD	DI	14-CP-01	3	5	1	140DAI55300	
_.		CONVEYOR CONTROLS RECEPTACLE # 1 IN USE	DI	14-CP-01	3	5	2	140DAI55300	
_.		CONVEYOR CONTROLS RECEPTACLE # 2 IN USE	DI	14-CP-01	3	5	3	140DAI55300	
_.		CONVEYOR CONTROLS BOTH RECEPTACLES IN USE	DI	14-CP-01	3	5	4	140DAI55300	
_.		CONVEYOR CONTROLS NEITHER RECEPTACLE IN USE	DI	14-CP-01	3	5	5	140DAI55300	
_.		HS-P12-4 EMERGENCY STOP	DI	14-CP-01	3	5	6	140DAI55300	
_.		CONVEYOR #3 OPEN GATE 15-2 (GATE 4)	DI	14-CP-01	3	5	7	140DAI55300	
_.		CONVEYOR #3 CLOSE GATE 15-2 (GATE 4)	DI	14-CP-01	3	5	8	140DAI55300	
_.		CONVEYOR #3 OPEN GATE 15-3 (GATE 3)	DI	14-CP-01	3	5	9	140DAI55300	
_.		CONVEYOR #3 CLOSE GATE 15-3 (GATE 3)	DI	14-CP-01	3	5	10	140DAI55300	
_.		CONVEYOR #3 DIRECTION EAST/WEST	DI	14-CP-01	3	5	11	140DAI55300	
_.		CONVEYOR #4 OPEN GATE 14-2 (GATE 6)	DI	14-CP-01	3	5	12	140DAI55300	
_.		CONVEYOR #4 CLOSE GATE 14-2 (GATE 6)	DI	14-CP-01	3	5	13	140DAI55300	
_.		CONVEYOR #4 OPEN GATE 14-3 (GATE 5)	DI	14-CP-01	3	5	14	140DAI55300	
_.		CONVEYOR #4 CLOSE GATE 14-3 (GATE 5)	DI	14-CP-01	3	5	15	140DAI55300	
_.		CONVEYOR #4 DIRECTION EAST/WEST	DI	14-CP-01	3	5	16	140DAI55300	
_.		CONVEYOR #5 OPEN GATE 17-2 (GATE 8)	DI	14-CP-01	3	5	17	140DAI55300	
_.		CONVEYOR #5 CLOSE GATE 17-2 (GATE 8)	DI	14-CP-01	3	5	18	140DAI55300	
_.		CONVEYOR #5 OPEN GATE 17-3 (GATE 7)	DI	14-CP-01	3	5	19	140DAI55300	
_.		CONVEYOR #5 CLOSE GATE 17-3 (GATE 7)	DI	14-CP-01	3	5	20	140DAI55300	
_.		CONVEYOR #5 DIRECTION EAST/WEST	DI	14-CP-01	3	5	21	140DAI55300	
_.		CONVEYOR #6 OPEN GATE 16-2 (GATE 10)	DI	14-CP-01	3	5	22	140DAI55300	
_.		CONVEYOR #6 CLOSE GATE 16-2 (GATE 10)	DI	14-CP-01	3	5	23	140DAI55300	
_.		CONVEYOR #6 OPEN GATE 16-3 (GATE 9)	DI	14-CP-01	3	5	24	140DAI55300	
_.		CONVEYOR #6 CLOSE GATE 16-3 (GATE 9)	DI	14-CP-01	3	5	25	140DAI55300	
_.		CONVEYOR #6 DIRECTION EAST/WEST	DI	14-CP-01	3	5	26	140DAI55300	
_.		TRUCK BAY AREA SOLIDS ODOR CONTROL FAN ON	DI	14-CP-01	3	5	27	140DAI55300	
_.		HOOD EXHAUST FAN #1 ON	DI	14-CP-01	3	5	28	140DAI55300	
_.		HOOD EXHAUST FAN #2 ON	DI	14-CP-01	3	5	29	140DAI55300	
_.		OFFICE/INSTRUMENT STORAGE SUPPLY FAN ON	DI	14-CP-01	3	5	30	140DAI55300	
_.		POLYMER AREA SUPPLY FAN ON	DI	14-CP-01	3	5	31	140DAI55300	
_.									
_.		POLYMER AREA EXHAUST FAN ON	DI	14-CP-01	3	6	0	140DAI55300	
_.		SOLIDS PRESS ROOM SUPPLY FAN #1 ON	DI	14-CP-01	3	6	1	140DAI55300	
_.		SOLIDS PRESS ROOM SUPPLY FAN #2 ON	DI	14-CP-01	3	6	2	140DAI55300	
_.		SOLIDS PRESS ROOM SUPPLY FAN #3 ON	DI	14-CP-01	3	6	3	140DAI55300	
_.		SOLIDS PRESS ROOM SUPPLY FAN #4 ON	DI	14-CP-01	3	6	4	140DAI55300	
_.		SOLIDS BIULDING EMERGENCY EYESWASH IN USE	DI	14-CP-01	3	6	5	140DAI55300	
_.		SCUM PUMP DISCHARGE VALVES REMOTE (12-V-01-S)	DI	14-CP-01	3	6	6	140DAI55300	
_.		SCUM PUMP DISCHARGE VALVES LIMIT SWITCH OPEN(12-V-01-S)	DI	14-CP-01	3	6	7	140DAI55300	
_.		SCUM PUMP DISCHARGE VALVES LIMIT SWITCH CLOSED(12-V-01-S)	DI	14-CP-01	3	6	8	140DAI55300	
_.		SCUM PUMP DISCHARGE VALVES REMOTE (12-V-02-S)	DI	14-CP-01	3	6	9	140DAI55300	
_.		SCUM PUMP DISCHARGE VALVES LIMIT SWITCH OPEN(12-V-02-S)	DI	14-CP-01	3	6	10	140DAI55300	
_.		SCUM PUMP DISCHARGE VALVES LIMIT SWITCH CLOSED(12-V-02-S)	DI	14-CP-01	3	6	11	140DAI55300	
_.		CONVEYOR 1 OPEN GATE 13-1	DI	14-CP-01	3	6	12	140DAI55300	
_.		CONVEYOR 1 CLOSE GATE 13-1	DI	14-CP-01	3	6	13	140DAI55300	
_.		CONVEYOR 2 OPEN GATE 12-1	DI	14-CP-01	3	6	14	140DAI55300	
_.		CONVEYOR 2 CLOSE GATE 12-1	DI	14-CP-01	3	6	15	140DAI55300	
_.		SPARE	DI	14-CP-01	3	6	16	140DAI55300	
_.		SPARE	DI	14-CP-01	3	6	17	140DAI55300	
_.		SPARE	DI	14-CP-01	3	6	18	140DAI55300	
_.		SPARE	DI	14-CP-01	3	6	19	140DAI55300	
_.		SPARE	DI	14-CP-01	3	6	20	140DAI55300	
_.		SPARE	DI	14-CP-01	3	6	21	140DAI55300	
_.		SPARE	DI	14-CP-01	3	6	22	140DAI55300	
_.		SPARE	DI	14-CP-01	3	6	23	140DAI55300	
_.		SPARE	DI	14-CP-01	3	6	24	140DAI55300	
_.		SPARE	DI	14-CP-01	3	6	25	140DAI55300	

13400 APPENDIX B
EXISTING IO LIST

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TAG NAME	ALARM/STATUS RANGE	DESCRIPTIONS	I/O TYPE	PANEL/RTU LOCATION	RACK	SLOT	CHANNEL	MODULE #	REMARKS
_.		SPARE	DI	14-CP-01	3	6	26	140DAI55300	
_.		SPARE	DI	14-CP-01	3	6	27	140DAI55300	
_.		SPARE	DI	14-CP-01	3	6	28	140DAI55300	
_.		SPARE	DI	14-CP-01	3	6	29	140DAI55300	
_.		SPARE	DI	14-CP-01	3	6	30	140DAI55300	
_.		SPARE	DI	14-CP-01	3	6	31	140DAI55300	
_.									
_.		BELT FILTER PRESS #1 RUN	DO	14-CP-01	3	8	0	140DRA84000	
_.		BELT FILTER PRESS #1 LOADSHED	DO	14-CP-01	3	8	1	140DRA84000	
_.		BELT FILTER PRESS #1 INCREASE SPEED	DO	14-CP-01	3	8	2	140DRA84000	
_.		BELT FILTER PRESS #1 DECREASE SPEED	DO	14-CP-01	3	8	3	140DRA84000	
_.		BELT FILTER PRESS #2 RUN	DO	14-CP-01	3	8	4	140DRA84000	
_.		BELT FILTER PRESS #2 LOADSHED	DO	14-CP-01	3	8	5	140DRA84000	
_.		BELT FILTER PRESS #2 INCREASE SPEED	DO	14-CP-01	3	8	6	140DRA84000	
_.		BELT FILTER PRESS #2 DECREASE SPEED	DO	14-CP-01	3	8	7	140DRA84000	
_.		SLUDGE FEED VALVE OPEN (12-V-02-WAS)	DO	14-CP-01	3	8	8	140DRA84000	
_.		SLUDGE FEED VALVE CLOSE (12-V-02-WAS)	DO	14-CP-01	3	8	9	140DRA84000	
_.		SLUDGE PURGE VALVE OPEN (12-V-01-UW)	DO	14-CP-01	3	8	10	140DRA84000	
_.		SLUDGE PURGE VALVE CLOSE (12-V-01-UW)	DO	14-CP-01	3	8	11	140DRA84000	
_.		BELT PRESS FEED PUMP #1 RUN	DO	14-CP-01	3	8	12	140DRA84000	
_.		BELT PRESS FEED PUMP #1 START PERMISSIVE	DO	14-CP-01	3	8	13	140DRA84000	
_.		BELT PRESS FEED PUMP #2 RUN	DO	14-CP-01	3	8	14	140DRA84000	
_.		BELT PRESS FEED PUMP #2 START PERMISSIVE	DO	14-CP-01	3	8	15	140DRA84000	
_.									
_.		BELT PRESS FEED PUMP #3 RUN	DO	14-CP-01	3	9	0	140DRA84000	
_.		BELT PRESS FEED PUMP #3 START PERMISSIVE	DO	14-CP-01	3	9	1	140DRA84000	
_.		WASHWATER PUMP #1 RUN	DO	14-CP-01	3	9	2	140DRA84000	
_.		WASHWATER PUMP #1 LOADSHED	DO	14-CP-01	3	9	3	140DRA84000	
_.		WASHWATER PUMP #2 RUN	DO	14-CP-01	3	9	4	140DRA84000	
_.		WASHWATER PUMP #2 LOADSHED	DO	14-CP-01	3	9	5	140DRA84000	
_.		POLYMERMIX BLEND UNIT #1 RUN	DO	14-CP-01	3	9	6	140DRA84000	
_.		POLYMERMIX BLEND UNIT #1 LOADSHED	DO	14-CP-01	3	9	7	140DRA84000	
_.		POLYMERMIX BLEND UNIT #2 RUN	DO	14-CP-01	3	9	8	140DRA84000	
_.		POLYMERMIX BLEND UNIT #2 LOADSHED	DO	14-CP-01	3	9	9	140DRA84000	
_.		POLYMERMIX BLEND UNIT #3 RUN	DO	14-CP-01	3	9	10	140DRA84000	
_.		POLYMERMIX BLEND UNIT #3 LOADSHED	DO	14-CP-01	3	9	11	140DRA84000	
_.		FILTRATE PUMP #1 RUN	DO	14-CP-01	3	9	12	140DRA84000	
_.		FILTRATE PUMP #1 LOADSHED	DO	14-CP-01	3	9	13	140DRA84000	
_.		FILTRATE PUMP #2 RUN	DO	14-CP-01	3	9	14	140DRA84000	
_.		FILTRATE PUMP #2 LOADSHED	DO	14-CP-01	3	9	15	140DRA84000	
_.									
_.		CONVEYOR CONTROLS ACTIVE	DO	14-CP-01	3	10	0	140DRA84000	
_.		CONVEYOR CONTROLS SETUP OK PRESS 1	DO	14-CP-01	3	10	1	140DRA84000	
_.		CONVEYOR CONTROLS SETUP OK PRESS 2	DO	14-CP-01	3	10	2	140DRA84000	
_.		CONVEYOR #1 GATE 13-1 OPEN	DO	14-CP-01	3	10	3	140DRA84000	
_.		CONVEYOR #1 GATE 13-1 CLOSED	DO	14-CP-01	3	10	4	140DRA84000	
_.		CONVEYOR #2 GATE 12-1 OPEN	DO	14-CP-01	3	10	5	140DRA84000	
_.		CONVEYOR #2 GATE 12-1 CLOSED	DO	14-CP-01	3	10	6	140DRA84000	
_.		CONVEYOR #3 NW #3 GATE 15-2 OPEN	DO	14-CP-01	3	10	7	140DRA84000	
_.		CONVEYOR #3 NW #3 GATE 15-2 CLOSED	DO	14-CP-01	3	10	8	140DRA84000	
_.		CONVEYOR #3 NW #2 GATE 15-3 OPEN	DO	14-CP-01	3	10	9	140DRA84000	
_.		CONVEYOR #3 NW #2 GATE 15-3 CLOSED	DO	14-CP-01	3	10	10	140DRA84000	
_.		CONVEYOR #3 NW CONVEYOR RUN EAST	DO	14-CP-01	3	10	11	140DRA84000	
_.		CONVEYOR #3 NW CONVEYOR RUN WEST	DO	14-CP-01	3	10	12	140DRA84000	
_.		CONVEYOR #4 NE #2 GATE 14-2 OPEN	DO	14-CP-01	3	10	13	140DRA84000	
_.		CONVEYOR #4 NE #2 GATE 14-2 CLOSED	DO	14-CP-01	3	10	14	140DRA84000	
_.		CONVEYOR #4 NE #3 GATE 14-3 OPEN	DO	14-CP-01	3	10	15	140DRA84000	
_.									
_.		CONVEYOR #4 NE #3 GATE 14-3 CLOSED	DO	14-CP-01	3	11	0	140DRA84000	
_.		CONVEYOR #4 NE CONVEYOR RUN EAST	DO	14-CP-01	3	11	1	140DRA84000	
_.		CONVEYOR #4 NE CONVEYOR RUN WEST	DO	14-CP-01	3	11	2	140DRA84000	
_.		CONVEYOR #5 SW #3 GATE 17-2 OPEN	DO	14-CP-01	3	11	3	140DRA84000	

13400 APPENDIX B
EXISTING IO LIST

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TAG NAME	ALARM/STATUS RANGE	DESCRIPTIONS	I/O TYPE	PANEL/RTU LOCATION	RACK	SLOT	CHANNEL	MODULE #	REMARKS
_.		CONVEYOR #5 SW #3 GATE 17-2 CLOSED	DO	14-CP-01	3	11	4	140DRA84000	
_.		CONVEYOR #5 SW #2 GATE 17-3 OPEN	DO	14-CP-01	3	11	5	140DRA84000	
_.		CONVEYOR #5 SW #2 GATE 17-3 CLOSED	DO	14-CP-01	3	11	6	140DRA84000	
_.		CONVEYOR #5 SW CONVEYOR RUN EAST	DO	14-CP-01	3	11	7	140DRA84000	
_.		CONVEYOR #5 SW CONVEYOR RUN WEST	DO	14-CP-01	3	11	8	140DRA84000	
_.		CONVEYOR #6 SE#2 GATE 16-2 OPEN	DO	14-CP-01	3	11	9	140DRA84000	
_.		CONVEYOR #6 SE#2 GATE 16-2 CLOSE	DO	14-CP-01	3	11	10	140DRA84000	
_.		CONVEYOR #6 SE#3 GATE 16-3 OPEN	DO	14-CP-01	3	11	11	140DRA84000	
_.		CONVEYOR #6 SE#3 GATE 16-3 CLOSE	DO	14-CP-01	3	11	12	140DRA84000	
_.		CONVEYOR #6 SE CONVEYOR RUN EAST	DO	14-CP-01	3	11	13	140DRA84000	
_.		CONVEYOR #6 SE CONVEYOR RUN WEST	DO	14-CP-01	3	11	14	140DRA84000	
_.		TRUCK BAY AREA SOLIDS ODOR CONTROL FAN LOADSHED	DO	14-CP-01	3	11	15	140DRA84000	
_.									
_.		HOOD EXHAUST FAN #1 LOADSHED	DO	14-CP-01	3	12	0	140DRA84000	
_.		HOOD EXHAUST FAN #2 LOADSHED	DO	14-CP-01	3	12	1	140DRA84000	
_.		OFFICE/INSTRUMENT STORAGE SUPPLY FAN LOADSHED	DO	14-CP-01	3	12	2	140DRA84000	
_.		POLYMER AREA SUPPLY FAN LOADSHED	DO	14-CP-01	3	12	3	140DRA84000	
_.		POLYMER AREA EXHAUST FAN LOADSHED	DO	14-CP-01	3	12	4	140DRA84000	
_.		SOLIDS PRESS ROOM SUPPLY FAN #1 LOADSHED	DO	14-CP-01	3	12	5	140DRA84000	
_.		SOLIDS PRESS ROOM SUPPLY FAN #2 LOADSHED	DO	14-CP-01	3	12	6	140DRA84000	
_.		SOLIDS PRESS ROOM SUPPLY FAN #3 LOADSHED	DO	14-CP-01	3	12	7	140DRA84000	
_.		SOLIDS PRESS ROOM SUPPLY FAN #4 LOADSHED	DO	14-CP-01	3	12	8	140DRA84000	
_.		TRUCK BAY DOOR EAST ALARM	DO	14-CP-01	3	12	9	140DRA84000	
_.		ANNUNCIATOR ALARMING PRESS #1 SYSTEM FAIL	DO	14-CP-01	3	12	10	140DRA84000	
_.		ANNUNCIATOR ALARMING PRESS #2 SYSTEM FAIL	DO	14-CP-01	3	12	11	140DRA84000	
_.		ANNUNCIATOR ALARMING POLYBLEND UNITS FAIL	DO	14-CP-01	3	12	12	140DRA84000	
_.		ANNUNCIATOR ALARMING FILTRATE PUMP FAIL	DO	14-CP-01	3	12	13	140DRA84000	
_.		ANNUNCIATOR ALARMING CONVEYOR FAIL	DO	14-CP-01	3	12	14	140DRA84000	
_.		SCUM PUMP DISCHARGE VALVES CLOSE	DO	14-CP-01	3	12	15	140DRA84000	
_.									
_.		SCUM PUMP DISCHARGE VALVES (12-V-01-S) OPEN	DO	14-CP-01	4	3	0	140DRA84000	
_.		SCUM PUMP DISCHARGE VALVES (12-V-02-S) OPEN	DO	14-CP-01	4	3	1	140DRA84000	
_.		SCUM PUMP DISCHARGE VALVES (12-V-02-S) CLOSE	DO	14-CP-01	4	3	2	140DRA84000	
_.		UNKNOWN	DO	14-CP-01	4	3	3	140DRA84000	
_.		SPARE	DO	14-CP-01	4	3	4	140DRA84000	
_.		SPARE	DO	14-CP-01	4	3	5	140DRA84000	
_.		SPARE	DO	14-CP-01	4	3	6	140DRA84000	
_.		SPARE	DO	14-CP-01	4	3	7	140DRA84000	
_.		SPARE	DO	14-CP-01	4	3	8	140DRA84000	
_.		SPARE	DO	14-CP-01	4	3	9	140DRA84000	
_.		SPARE	DO	14-CP-01	4	3	10	140DRA84000	
_.		SPARE	DO	14-CP-01	4	3	11	140DRA84000	
_.		SPARE	DO	14-CP-01	4	3	12	140DRA84000	
_.		SPARE	DO	14-CP-01	4	3	13	140DRA84000	
_.		SPARE	DO	14-CP-01	4	3	14	140DRA84000	
_.		SPARE	DO	14-CP-01	4	3	15	140DRA84000	
_.									
_.		BELT DRIVE SYSTEM #1 SPEED	AI	14-CP-01	4	5	0	140ACI04000	
_.		BELT DRIVE SYSTEM #2 SPEED	AI	14-CP-01	4	5	1	140ACI04000	
_.		BELT PRESS FEED PUMP #1 SPEED	AI	14-CP-01	4	5	2	140ACI04000	
_.		BELT PRESS FEED PUMP #1 FLOW	AI	14-CP-01	4	5	3	140ACI04000	
_.		BELT PRESS FEED PUMP #2 SPEED	AI	14-CP-01	4	5	4	140ACI04000	
_.		BELT PRESS FEED PUMP #2 FLOW	AI	14-CP-01	4	5	5	140ACI04000	
_.		BELT PRESS FEED PUMP #3 SPEED	AI	14-CP-01	4	5	6	140ACI04000	
_.		BELT PRESS FEED PUMP #3 FLOW	AI	14-CP-01	4	5	7	140ACI04000	
_.		POLYMER MIX BLEND UNIT #1 SPEED FEEDBACK	AI	14-CP-01	4	5	8	140ACI04000	
_.		POLYMER MIX BLEND UNIT #2 SPEED FEEDBACK	AI	14-CP-01	4	5	9	140ACI04000	
_.		POLYMER MIX BLEND UNIT #3 SPEED FEEDBACK	AI	14-CP-01	4	5	10	140ACI04000	
_.		FILTRATE PUMP #2 FLOW	AI	14-CP-01	4	5	11	140ACI04000	
_.		SPARE	AI	14-CP-01	4	5	12	140ACI04000	
_.		SPARE	AI	14-CP-01	4	5	13	140ACI04000	
_.		SPARE	AI	14-CP-01	4	5	14	140ACI04000	

13400 APPENDIX B
EXISTING IO LIST

14-CP-01

TAG NAME	ALARM/STATUS RANGE	DESCRIPTIONS	I/O TYPE	PANEL/RTU LOCATION	RACK	SLOT	CHANNEL	MODULE #	REMARKS
_.		SPARE	AI	14-CP-01	4	5	15	140ACI04000	
_.									
_.		BELT FILTER PRESS #1 SLUDGE PUMP SPEED	AO	14-CP-01	4	7	0	140ACO13000	
_.		BELT FILTER PRESS #1 POLYMER PUMP SPEED	AO	14-CP-01	4	7	1	140ACO13000	
_.		BELT FILTER PRESS #2 SLUDGE PUMP SPEED	AO	14-CP-01	4	7	2	140ACO13000	
_.		BELT FILTER PRESS #2 POLYMER PUMP SPEED	AO	14-CP-01	4	7	3	140ACO13000	
_.		BELT PRESS FEED PUMP #1 SPEED	AO	14-CP-01	4	7	4	140ACO13000	
_.		BELT PRESS FEED PUMP #2 SPEED	AO	14-CP-01	4	7	5	140ACO13000	
_.		BELT PRESS FEED PUMP #3 SPEED	AO	14-CP-01	4	7	6	140ACO13000	
_.		POLYMER MIX BLEND UNIT #1 SPEED	AO	14-CP-01	4	7	7	140ACO13000	
_.									
_.		POLYMER MIX BLEND UNIT #2 SPEED	AO	14-CP-01	4	8	0	140ACO13000	
_.		POLYMER MIX BLEND UNIT #3 SPEED	AO	14-CP-01	4	8	1	140ACO13000	
_.		SPARE	AO	14-CP-01	4	8	2	140ACO13000	
_.		SPARE	AO	14-CP-01	4	8	3	140ACO13000	
_.		SPARE	AO	14-CP-01	4	8	4	140ACO13000	
_.		SPARE	AO	14-CP-01	4	8	5	140ACO13000	
_.		SPARE	AO	14-CP-01	4	8	6	140ACO13000	
_.		SPARE	AO	14-CP-01	4	8	7	140ACO13000	
_.									
_.									
_.									
		TOTAL I/O COUNT - AI:	**16**						
		DI:	**128**						
		DO:	**96**						
		AO:	**16**						

13400 APPENDIX B
EXISTING IO LIST

16-CP-01

TAG NAME	ALARM/STATUS RANGE	DESCRIPTIONS	I/O TYPE	PANEL/RTU LOCATION	RACK	SLOT	CHANNEL	MODULE #	REMARKS
_.		UPS TROUBLE	DI	16-CP-01	3	3	0	140DAI55300	
_.		INFLUENT GATE (11-G-01-PI) IN REMOTE	DI	16-CP-01	3	3	1	140DAI55300	
_.		INFLUENT GATE (11-G-01-PI) LIMIT SWITCH OPEN	DI	16-CP-01	3	3	2	140DAI55300	
_.		INFLUENT GATE (11-G-01-PI) LIMIT SWITCH CLOSED	DI	16-CP-01	3	3	3	140DAI55300	
_.		INFLUENT GATE (11-G-02-PI) IN REMOTE	DI	16-CP-01	3	3	4	140DAI55300	
_.		INFLUENT GATE (11-G-02-PI) LIMIT SWITCH OPEN	DI	16-CP-01	3	3	5	140DAI55300	
_.		INFLUENT GATE (11-G-02-PI) LIMIT SWITCH CLOSED	DI	16-CP-01	3	3	6	140DAI55300	
_.		INFLUENT CHANNEL LEVEL HIGH LEVEL	DI	16-CP-01	3	3	7	140DAI55300	
_.		INFLUENT CHANNEL LEVEL LOW LEVEL	DI	16-CP-01	3	3	8	140DAI55300	
_.		INFLUENT PUMP #1 IN BYPASS	DI	16-CP-01	3	3	9	140DAI55300	
_.		INFLUENT PUMP #1 ASD 11-P-01-P1 ASD ON	DI	16-CP-01	3	3	10	140DAI55300	
_.		INFLUENT PUMP #1 11-LP-01 IN REMOTE	DI	16-CP-01	3	3	11	140DAI55300	
_.		INFLUENT PUMP #1 ASD 11-P-01-P1 ASD ON	DI	16-CP-01	3	3	12	140DAI55300	
_.		INFLUENT PUMP #1 ASD 11-P-01-P1 BYPASS ON	DI	16-CP-01	3	3	13	140DAI55300	
_.		INFLUENT PUMP #1 ASD 11-P-01-P1 ASD FAIL	DI	16-CP-01	3	3	14	140DAI55300	
_.		INFLUENT PUMP #2 ASD 11-P-02-P1 IN BYPASS	DI	16-CP-01	3	3	15	140DAI55300	
_.		INFLUENT PUMP #2 ASD 11-P-02-P1 IN ASD	DI	16-CP-01	3	3	16	140DAI55300	
_.		INFLUENT PUMP #2 11-LP-01 IN REMOTE	DI	16-CP-01	3	3	17	140DAI55300	
_.		INFLUENT PUMP #2 ADS ON	DI	16-CP-01	3	3	18	140DAI55300	
_.		INFLUENT PUMP #2 BYPASS ON	DI	16-CP-01	3	3	19	140DAI55300	
_.		INFLUENT PUMP #2 ASD FAIL	DI	16-CP-01	3	3	20	140DAI55300	
_.		INFLUENT PUMP #3 IN BYPASS	DI	16-CP-01	3	3	21	140DAI55300	
_.		INFLUENT PUMP #3 IN ASD	DI	16-CP-01	3	3	22	140DAI55300	
_.		INFLUENT PUMP #3 11-LP-01 IN REMOTE	DI	16-CP-01	3	3	23	140DAI55300	
_.		INFLUENT PUMP #3 ADS ON	DI	16-CP-01	3	3	24	140DAI55300	
_.		INFLUENT PUMP #3 BYPASS ON	DI	16-CP-01	3	3	25	140DAI55300	
_.		INFLUENT PUMP #3 ASD FAIL	DI	16-CP-01	3	3	26	140DAI55300	
_.		WET WELL FLOAT LEVEL SWITCH LSH-A6-1	DI	16-CP-01	3	3	27	140DAI55300	
_.		WET WELL FLOAT LEVEL SWITCH LSL-A6-1	DI	16-CP-01	3	3	28	140DAI55300	
_.		WET WELL FLOAT LEVEL SWITCH SCREEN LEVEL LASH-B5	DI	16-CP-01	3	3	29	140DAI55300	
_.		WET WELL FLOAT LEVEL SWITCH HBS-1 ACTIVE	DI	16-CP-01	3	3	30	140DAI55300	
_.		WET WELL FLOAT LEVEL SWITCH HBS ENABLE/DISABLE	DI	16-CP-01	3	3	31	140DAI55300	
_.									
_.		INFLUENT PUMP #4 ASD-11-P-04-P1 IN BYPASS	DI	16-CP-01	3	4	0	140DAI55300	
_.		INFLUENT PUMP #4 ASD-11-P-04-P1 IN ASD	DI	16-CP-01	3	4	1	140DAI55300	
_.		INFLUENT PUMP #4 11-LP-01 IN REMOTE	DI	16-CP-01	3	4	2	140DAI55300	
_.		INFLUENT PUMP #4 ASD-11-P-04-P1 ASD ON	DI	16-CP-01	3	4	3	140DAI55300	
_.		INFLUENT PUMP #4 ASD-11-P-04-P1 BYPASS ON	DI	16-CP-01	3	4	4	140DAI55300	
_.		INFLUENT PUMP #4 ASD-11-P-04-P1 ASD FAIL	DI	16-CP-01	3	4	5	140DAI55300	
_.		INFLUENT PUMP #5 ASD-11-P-05-P1 IN BYPASS	DI	16-CP-01	3	4	6	140DAI55300	
_.		INFLUENT PUMP #5 ASD-11-P-05-P1 IN ASD	DI	16-CP-01	3	4	7	140DAI55300	
_.		INFLUENT PUMP #5 11-LP-01 IN REMOTE	DI	16-CP-01	3	4	8	140DAI55300	
_.		INFLUENT PUMP #5 ASD-11-P-05-P1 ASD ON	DI	16-CP-01	3	4	9	140DAI55300	
_.		INFLUENT PUMP #5 ASD-11-P-05-P1 BYPASS ON	DI	16-CP-01	3	4	10	140DAI55300	
_.		INFLUENT PUMP #5 ASD-11-P-05-P1 ASD FAIL	DI	16-CP-01	3	4	11	140DAI55300	
_.		INFLUENT PUMP #5 ASD-11-P-05-P1 ASD FAIL	DI	16-CP-01	3	4	12	140DAI55300	
_.		SCREENINGS INLET SAMPLER CONTROLS	DI	16-CP-01	3	4	13	140DAI55300	
_.		WET WELL FLOAT LEVEL SWITCHES HBS-2 ACTIVE	DI	16-CP-01	3	4	14	140DAI55300	
_.		SCREENINGS INLET 12-C-01-P1 SAMPLER CONTROLS	DI	16-CP-01	3	4	15	140DAI55300	
_.		FILTER SCREEN #1 IN REMOTE	DI	16-CP-01	3	4	16	140DAI55300	
_.		FILTER SCREEN #1 READY	DI	16-CP-01	3	4	17	140DAI55300	
_.		FILTER SCREEN #1 SCREEN RUNNING	DI	16-CP-01	3	4	18	140DAI55300	
_.		FILTER SCREEN #1 COMPACTOR RUNNING	DI	16-CP-01	3	4	19	140DAI55300	
_.		FILTER SCREEN #1 WASHER RUNNING	DI	16-CP-01	3	4	20	140DAI55300	
_.		FILTER SCREEN #1 E-STOP	DI	16-CP-01	3	4	21	140DAI55300	
_.		FILTER SCREEN #1 FAIL	DI	16-CP-01	3	4	22	140DAI55300	
_.		FILTER #1 INLET GATE IN REMOTE	DI	16-CP-01	3	4	23	140DAI55300	
_.		FILTER #1 INLET GATE LIMIT SWITCH OPEN	DI	16-CP-01	3	4	24	140DAI55300	
_.		FILTER #1 INLET GATE LIMIT SWITCH CLOSED	DI	16-CP-01	3	4	25	140DAI55300	
_.		FILTER #1 OUTLET GATE IN REMOTE	DI	16-CP-01	3	4	26	140DAI55300	
_.		FILTER #1 OUTLET GATE LIMIT SWITCH OPEN	DI	16-CP-01	3	4	27	140DAI55300	
_.		FILTER #1 OUTLET GATE LIMIT SWITCH CLOSED	DI	16-CP-01	3	4	28	140DAI55300	
_.		FILTER SCREEN #2 IN REMOTE	DI	16-CP-01	3	4	29	140DAI55300	

13400 APPENDIX B
EXISTING IO LIST

16-CP-01

TAG NAME	ALARM/STATUS RANGE	DESCRIPTIONS	I/O TYPE	PANEL/RTU LOCATION	RACK	SLOT	CHANNEL	MODULE #	REMARKS
_.		FILTER SCREEN #2 READY	DI	16-CP-01	3	4	30	140DAI55300	
_.		FILTER SCREEN #2 SCREEN RUNNING	DI	16-CP-01	3	4	31	140DAI55300	
_.									
_.		FILTER SCREEN #2 COMPACTOR RUNNING	DI	16-CP-01	3	5	0	140DAI55300	
_.		FILTER SCREEN #2 WASHER RUNNING	DI	16-CP-01	3	5	1	140DAI55300	
_.		FILTER SCREEN #2 E-STOP	DI	16-CP-01	3	5	2	140DAI55300	
_.		FILTER SCREEN #2 FAIL	DI	16-CP-01	3	5	3	140DAI55300	
_.		FILTER #2 INLET GATE IN REMOTE	DI	16-CP-01	3	5	4	140DAI55300	
_.		FILTER #2 INLET GATE LIMIT SWITCH OPEN	DI	16-CP-01	3	5	5	140DAI55300	
_.		FILTER #2 INLET GATE LIMIT SWITCH CLOSED	DI	16-CP-01	3	5	6	140DAI55300	
_.		FILTER #2 OUTLET GATE IN REMOTE	DI	16-CP-01	3	5	7	140DAI55300	
_.		FILTER #2 OUTLET GATE LIMIT SWITCH OPEN	DI	16-CP-01	3	5	8	140DAI55300	
_.		FILTER #2 OUTLET GATE LIMIT SWITCH CLOSED	DI	16-CP-01	3	5	9	140DAI55300	
_.		FILTER #3 INLET GATE IN REMOTE	DI	16-CP-01	3	5	10	140DAI55300	
_.		FILTER #3 INLET GATE LIMIT SWITCH OPEN	DI	16-CP-01	3	5	11	140DAI55300	
_.		FILTER #3 INLET GATE LIMIT SWITCH CLOSED	DI	16-CP-01	3	5	12	140DAI55300	
_.		FILTER #3 OUTLET GATE IN REMOTE	DI	16-CP-01	3	5	13	140DAI55300	
_.		FILTER #3 OUTLET GATE LIMIT SWITCH OPEN	DI	16-CP-01	3	5	14	140DAI55300	
_.		FILTER #3 OUTLET GATE LIMIT SWITCH CLOSED	DI	16-CP-01	3	5	15	140DAI55300	
_.		GRIT REMOVAL GRIT AGITATOR IN REMOTE	DI	16-CP-01	3	5	16	140DAI55300	
_.		GRIT REMOVAL GRIT AGITATOR ON LOW	DI	16-CP-01	3	5	17	140DAI55300	
_.		GRIT REMOVAL GRIT AGITATOR ON HIGH	DI	16-CP-01	3	5	18	140DAI55300	
_.		GRIT REMOVAL GRIT AGITATOR HIGH TORQUE	DI	16-CP-01	3	5	19	140DAI55300	
_.		GRIT REMOVAL GRIT AGITATOR HIGH HIGH TORQUE	DI	16-CP-01	3	5	20	140DAI55300	
_.		GRIT REMOVAL GRIT AGITATOR OVERLOAD	DI	16-CP-01	3	5	21	140DAI55300	
_.		GRIT REMOVAL GRIT AGITATOR SAMPLER CONTROLS	DI	16-CP-01	3	5	22	140DAI55300	
_.		GRIT REMOVAL GRIT PUMP #1 IN REMOTE	DI	16-CP-01	3	5	23	140DAI55300	
_.		GRIT REMOVAL GRIT PUMP #1 RUNNING	DI	16-CP-01	3	5	24	140DAI55300	
_.		GRIT REMOVAL GRIT PUMP #1 FAIL	DI	16-CP-01	3	5	25	140DAI55300	
_.		GRIT REMOVAL GRIT PUMP #2 IN REMOTE	DI	16-CP-01	3	5	26	140DAI55300	
_.		GRIT REMOVAL GRIT PUMP #2 RUNNING	DI	16-CP-01	3	5	27	140DAI55300	
_.		GRIT REMOVAL GRIT PUMP #2 FAIL	DI	16-CP-01	3	5	28	140DAI55300	
_.		GRIT REMOVAL GRIT CLASSIFIER IN REMOTE	DI	16-CP-01	3	5	29	140DAI55300	
_.		GRIT REMOVAL GRIT CLASSIFIER E-STOP	DI	16-CP-01	3	5	30	140DAI55300	
_.		GRIT REMOVAL GRIT CLASSIFIER RUNNING	DI	16-CP-01	3	5	31	140DAI55300	
_.									
_.		GRIT REMOVAL GRIT CLASSIFIER FAIL	DI	16-CP-01	3	6	0	140DAI55300	
_.		GRIT REMOVAL GRIT CLASSIFIER NO FLOW	DI	16-CP-01	3	6	1	140DAI55300	
_.		DENITRIFICATION MIXER 1A IN REMOTE	DI	16-CP-01	3	6	2	140DAI55300	
_.		DENITRIFICATION MIXER 1A PUMP ON	DI	16-CP-01	3	6	3	140DAI55300	
_.		DENITRIFICATION MIXER 1A OVERLOAD	DI	16-CP-01	3	6	4	140DAI55300	
_.		DENITRIFICATION MIXER 1B IN REMOTE	DI	16-CP-01	3	6	5	140DAI55300	
_.		DENITRIFICATION MIXER 1B PUMP ON	DI	16-CP-01	3	6	6	140DAI55300	
_.		DENITRIFICATION MIXER 1B OVERLOAD	DI	16-CP-01	3	6	7	140DAI55300	
_.		DENITRIFICATION MIXER 2A IN REMOTE	DI	16-CP-01	3	6	8	140DAI55300	
_.		DENITRIFICATION MIXER 2A PUMP ON	DI	16-CP-01	3	6	9	140DAI55300	
_.		DENITRIFICATION MIXER 2A OVERLOAD	DI	16-CP-01	3	6	10	140DAI55300	
_.		DENITRIFICATION MIXER 2B IN REMOTE	DI	16-CP-01	3	6	11	140DAI55300	
_.		DENITRIFICATION MIXER 2B PUMP ON	DI	16-CP-01	3	6	12	140DAI55300	
_.		DENITRIFICATION MIXER 2B OVERLOAD	DI	16-CP-01	3	6	13	140DAI55300	
_.		AERATOR 1A IN BYPASS	DI	16-CP-01	3	6	14	140DAI55300	
_.		AERATOR 1A IN ASD	DI	16-CP-01	3	6	15	140DAI55300	
_.		AERATOR 1A IN REMOTE	DI	16-CP-01	3	6	16	140DAI55300	
_.		AERATOR 1A ASD ON	DI	16-CP-01	3	6	17	140DAI55300	
_.		AERATOR 1A IN BYPASS ON	DI	16-CP-01	3	6	18	140DAI55300	
_.		AERATOR 1A ASD FAIL	DI	16-CP-01	3	6	19	140DAI55300	
_.		AERATOR 1B IN BYPASS	DI	16-CP-01	3	6	20	140DAI55300	
_.		AERATOR 1B IN ASD	DI	16-CP-01	3	6	21	140DAI55300	
_.		AERATOR 1B IN REMOTE	DI	16-CP-01	3	6	22	140DAI55300	
_.		AERATOR 1B ASD ON	DI	16-CP-01	3	6	23	140DAI55300	
_.		AERATOR 1B BYPASS ON	DI	16-CP-01	3	6	24	140DAI55300	
_.		AERATOR 1B ASD FAIL	DI	16-CP-01	3	6	25	140DAI55300	

13400 APPENDIX B
EXISTING IO LIST

16-CP-01

TAG NAME	ALARM/STATUS RANGE	DESCRIPTIONS	I/O TYPE	PANEL/RTU LOCATION	RACK	SLOT	CHANNEL	MODULE #	REMARKS
_.		AERATOR 2A IN BYPASS	DI	16-CP-01	3	6	26	140DAI55300	
_.		AERATOR 2A IN ASD	DI	16-CP-01	3	6	27	140DAI55300	
_.		AERATOR 2A IN REMOTE	DI	16-CP-01	3	6	28	140DAI55300	
_.		AERATOR 2A ASD ON	DI	16-CP-01	3	6	29	140DAI55300	
_.		AERATOR 2A BYPASS ON	DI	16-CP-01	3	6	30	140DAI55300	
_.		AERATOR 2A ASD FAIL	DI	16-CP-01	3	6	31	140DAI55300	
_.									
_.		AERATOR 2B IN BYPASS	DI	16-CP-01	3	7	0	140DAI55300	
_.		AERATOR 2B IN ASD	DI	16-CP-01	3	7	1	140DAI55300	
_.		AERATOR 2B IN REMOTE	DI	16-CP-01	3	7	2	140DAI55300	
_.		AERATOR 2B ASD ON	DI	16-CP-01	3	7	3	140DAI55300	
_.		AERATOR 2B BYPASS ON	DI	16-CP-01	3	7	4	140DAI55300	
_.		AERATOR 2B ASD FAIL	DI	16-CP-01	3	7	5	140DAI55300	
_.		ML PUMP #1 IN REMOTE	DI	16-CP-01	3	7	6	140DAI55300	
_.		ML PUMP #1 RUNNING	DI	16-CP-01	3	7	7	140DAI55300	
_.		ML PUMP #1 FAIL	DI	16-CP-01	3	7	8	140DAI55300	
_.		ML PUMP #2 IN REMOTE	DI	16-CP-01	3	7	9	140DAI55300	
_.		ML PUMP #2 RUNNING	DI	16-CP-01	3	7	10	140DAI55300	
_.		ML PUMP #2 FAIL	DI	16-CP-01	3	7	11	140DAI55300	
_.		ML PUMP #3 IN REMOTE	DI	16-CP-01	3	7	12	140DAI55300	
_.		ML PUMP #3 RUNNING	DI	16-CP-01	3	7	13	140DAI55300	
_.		ML PUMP #3 FAIL	DI	16-CP-01	3	7	14	140DAI55300	
_.		SLUDGE BASIN LOW LEVEL	DI	16-CP-01	3	7	15	140DAI55300	
_.		SLUDGE BASIN MIXER #1 IN REMOTE	DI	16-CP-01	3	7	16	140DAI55300	
_.		SLUDGE BASIN MIXER #1 RUNNING	DI	16-CP-01	3	7	17	140DAI55300	
_.		SLUDGE BASIN MIXER #1 FAIL	DI	16-CP-01	3	7	18	140DAI55300	
_.		SLUDGE BASIN MIXER #2 IN REMOTE	DI	16-CP-01	3	7	19	140DAI55300	
_.		SLUDGE BASIN MIXER #2 RUNNING	DI	16-CP-01	3	7	20	140DAI55300	
_.		SLUDGE BASIN MIXER #2 FAIL	DI	16-CP-01	3	7	21	140DAI55300	
_.		SLUDGE BASIN MIXER #3 IN REMOTE	DI	16-CP-01	3	7	22	140DAI55300	
_.		SLUDGE BASIN MIXER #3 RUNNING	DI	16-CP-01	3	7	23	140DAI55300	
_.		SLUDGE BASIN MIXER #3 FAIL	DI	16-CP-01	3	7	24	140DAI55300	
_.		IPS SUPPLY FAN 11-F-01-FA ON	DI	16-CP-01	3	7	25	140DAI55300	
_.		IPS EXHAUST FAN 17-F-01-FA ON	DI	16-CP-01	3	7	26	140DAI55300	
_.		DUMPSTER ROOM EXHAUST FAN 17-F-02-FA ON	DI	16-CP-01	3	7	27	140DAI55300	
_.		SCREENINGS CHANNEL EXHAUST FAN #1 17-F-03-FA ON	DI	16-CP-01	3	7	28	140DAI55300	
_.		SCREENINGS CHANNEL EXHAUST FAN #2 17-F-04-FA ON	DI	16-CP-01	3	7	29	140DAI55300	
_.		HEADWORKS AIR FLOW AND COMBUSTIBLE GAS MONITORING ALARM	DI	16-CP-01	3	7	30	140DAI55300	
_.		HEADWORKS AIR FLOW AND COMBUSTIBLE GAS MONITORING LOW FLOW	DI	16-CP-01	3	7	31	140DAI55300	
_.									
_.		HEADWORKS COMBUSTIBLE GAS ANALYZER WARNING	DI	16-CP-01	3	8	0	140DAI55300	
_.		HEADWORKS COMBUSTIBLE GAS LOW AIR FLOW	DI	16-CP-01	3	8	1	140DAI55300	
_.		FAN ROOM SUPPLY FAN 12-F-01-FA ON	DI	16-CP-01	3	8	2	140DAI55300	
_.		FAN ROOM EXHAUST FAN 12-F-02-FA ON	DI	16-CP-01	3	8	3	140DAI55300	
_.		GRIT PUMP/STORAGE AREA SUPPLY FAN 12-F-03-FA ON	DI	16-CP-01	3	8	4	140DAI55300	
_.		GRIT PUMP/STORAGE AREA EXHAUST FAN 12-F-04-FA ON	DI	16-CP-01	3	8	5	140DAI55300	
_.		ELECTRICAL ROOM SUPPLY FAN 16-F-01-FA ON	DI	16-CP-01	3	8	6	140DAI55300	
_.		ELECTRICAL ROOM EXHAUST FAN 16-F-02-FA ON	DI	16-CP-01	3	8	7	140DAI55300	
_.		UTILITY AIR COMPESSOR #1 RUN	DI	16-CP-01	3	8	8	140DAI55300	
_.		UTILITY AIR COMPESSOR #2 RUN	DI	16-CP-01	3	8	9	140DAI55300	
_.		UTILITY AIR COMPESSORS FAIL	DI	16-CP-01	3	8	10	140DAI55300	
_.		UTILITY AIR COMPESSORS LOW PRESSURE	DI	16-CP-01	3	8	11	140DAI55300	
_.		STANDBY GENERATOR LEAK DETECTION	DI	16-CP-01	3	8	12	140DAI55300	
_.		STANDBY GENERATOR TROUBLE ALARM	DI	16-CP-01	3	8	13	140DAI55300	
_.		STANDBY GENERATOR FUEL TANK LOW LEVEL	DI	16-CP-01	3	8	14	140DAI55300	
_.		STANDBY GENERATOR RUNNING	DI	16-CP-01	3	8	15	140DAI55300	
_.		STANDBY GENERATOR SYS ATS IN NORMAL POSITION	DI	16-CP-01	3	8	16	140DAI55300	
_.		STANDBY GENERATOR SYS ATS IN STANDBY POSITION	DI	16-CP-01	3	8	17	140DAI55300	
_.		STANDBY GENERATOR SYS ATS IN LOSS OF UTILITY POWER	DI	16-CP-01	3	8	18	140DAI55300	
_.		PANEL 16-CP-01 24 VDC POWER OK	DI	16-CP-01	3	8	19	140DAI55300	
_.		OPERATION BUILDING FSHT2-5	DI	16-CP-01	3	8	20	140DAI55300	

13400 APPENDIX B
EXISTING IO LIST

16-CP-01

TAG NAME	ALARM/STATUS RANGE	DESCRIPTIONS	I/O TYPE	PANEL/RTU LOCATION	RACK	SLOT	CHANNEL	MODULE #	REMARKS
_.		SPARE	DI	16-CP-01	3	8	21	140DAI55300	
_.		SPARE	DI	16-CP-01	3	8	22	140DAI55300	
_.		SPARE	DI	16-CP-01	3	8	23	140DAI55300	
_.		SPARE	DI	16-CP-01	3	8	24	140DAI55300	
_.		SPARE	DI	16-CP-01	3	8	25	140DAI55300	
_.		SPARE	DI	16-CP-01	3	8	26	140DAI55300	
_.		SPARE	DI	16-CP-01	3	8	27	140DAI55300	
_.		SPARE	DI	16-CP-01	3	8	28	140DAI55300	
_.		SPARE	DI	16-CP-01	3	8	29	140DAI55300	
_.		SPARE	DI	16-CP-01	3	8	30	140DAI55300	
_.		SPARE	DI	16-CP-01	3	8	31	140DAI55300	
_.									
_.		INFLUENT GATE 11-G-01-PI OPEN	DO	16-CP-01	3	11	0	140DRA84000	
_.		INFLUENT GATE 11-G-01-PI CLOSE	DO	16-CP-01	3	11	1	140DRA84000	
_.		INFLUENT GATE 11-G-02-PI OPEN	DO	16-CP-01	3	11	2	140DRA84000	
_.		INFLUENT GATE 11-G-02-PI CLOSE	DO	16-CP-01	3	11	3	140DRA84000	
_.		INFLUENT PUMP #1 PLC CALL COMAND IF IN ASD AND REMOTE	DO	16-CP-01	3	11	4	140DRA84000	
_.		INFLUENT PUMP #1 PLC CALL COMAND IF IN BYPASS AND REMOTE	DO	16-CP-01	3	11	5	140DRA84000	
_.		INFLUENT PUMP #1 LOADSHED	DO	16-CP-01	3	11	6	140DRA84000	
_.		INFLUENT PUMP #2 PLC CALL COMAND IF IN ASD AND REMOTE	DO	16-CP-01	3	11	7	140DRA84000	
_.		INFLUENT PUMP #2 PLC CALL COMAND IF IN BYPASS AND REMOTE	DO	16-CP-01	3	11	8	140DRA84000	
_.		INFLUENT PUMP #2 LOADSHED	DO	16-CP-01	3	11	9	140DRA84000	
_.		INFLUENT PUMP #3 PLC CALL COMAND IF IN ASD AND REMOTE	DO	16-CP-01	3	11	10	140DRA84000	
_.		INFLUENT PUMP #3 PLC CALL COMAND IF IN BYPASS AND REMOTE	DO	16-CP-01	3	11	11	140DRA84000	
_.		INFLUENT PUMP #3 LOADSHED	DO	16-CP-01	3	11	12	140DRA84000	
_.		INFLUENT PUMP #4 PLC CALL COMAND IF IN ASD AND REMOTE	DO	16-CP-01	3	11	13	140DRA84000	
_.		INFLUENT PUMP #4 PLC CALL COMAND IF IN BYPASS AND REMOTE	DO	16-CP-01	3	11	14	140DRA84000	
_.		INFLUENT PUMP #4 LOADSHED	DO	16-CP-01	3	11	15	140DRA84000	
_.									
_.		INFLUENT PUMP #5 PLC CALL COMAND IF IN ASD AND REMOTE	DO	16-CP-01	3	12	0	140DRA84000	
_.		INFLUENT PUMP #5 PLC CALL COMAND IF IN BYPASS AND REMOTE	DO	16-CP-01	3	12	1	140DRA84000	
_.		INFLUENT PUMP #5 LOADSHED	DO	16-CP-01	3	12	2	140DRA84000	
_.		FILTER SCREEN #1 COMMENCE SCREEN CYCLE	DO	16-CP-01	3	12	3	140DRA84000	
_.		FILTER SCREEN #1 LOADSHED	DO	16-CP-01	3	12	4	140DRA84000	
_.		FILTER #1 INLET GATE OPEN COMMAND	DO	16-CP-01	3	12	5	140DRA84000	
_.		FILTER #1 INLET GATE CLOSE COMMAND	DO	16-CP-01	3	12	6	140DRA84000	
_.		FILTER #1 OUTLET GATE OPEN COMMAND	DO	16-CP-01	3	12	7	140DRA84000	
_.		FILTER #1 OUTLET GATE CLOSE COMMAND	DO	16-CP-01	3	12	8	140DRA84000	
_.		FILTER SCREEN #2 COMMENCE SCREEN CYCLE	DO	16-CP-01	3	12	9	140DRA84000	
_.		FILTER SCREEN #2 LOADSHED	DO	16-CP-01	3	12	10	140DRA84000	
_.		FILTER #2 INLET GATE OPEN COMMAND	DO	16-CP-01	3	12	11	140DRA84000	
_.		FILTER #2 INLET GATE CLOSE COMMAND	DO	16-CP-01	3	12	12	140DRA84000	
_.		FILTER #2 OUTLET GATE OPEN COMMAND	DO	16-CP-01	3	12	13	140DRA84000	
_.		FILTER #2 OUTLET GATE CLOSE COMMAND	DO	16-CP-01	3	12	14	140DRA84000	
_.		FILTER #3 INLET GATE OPEN COMMAND	DO	16-CP-01	3	12	15	140DRA84000	
_.									
_.		FILTER #3 INLET GATE CLOSE COMMAND	DO	16-CP-01	3	13	0	140DRA84000	
_.		FILTER #3 OUTLET GATE OPEN COMMAND	DO	16-CP-01	3	13	1	140DRA84000	
_.		FILTER #3 OUTLET GATE CLOSE COMMAND	DO	16-CP-01	3	13	2	140DRA84000	
_.		GRIT REMOVAL GRIT AGITATOR RUN COMMAND	DO	16-CP-01	3	13	3	140DRA84000	
_.		GRIT REMOVAL GRIT AGITATOR LOADSHED	DO	16-CP-01	3	13	4	140DRA84000	
_.		GRIT PUMP #1 RUN COMMAND	DO	16-CP-01	3	13	5	140DRA84000	
_.		GRIT PUMP #1 LOADSHED	DO	16-CP-01	3	13	6	140DRA84000	
_.		GRIT PUMP #2 RUN COMMAND	DO	16-CP-01	3	13	7	140DRA84000	
_.		GRIT PUMP #2 LOADSHED	DO	16-CP-01	3	13	8	140DRA84000	
_.		GRIT CLASSIFIER RUN COMMAND	DO	16-CP-01	3	13	9	140DRA84000	
_.		GRIT CLASSIFIER LOADSHED	DO	16-CP-01	3	13	10	140DRA84000	
_.		DENITRIFICATION MIXER 1A RUN	DO	16-CP-01	3	13	11	140DRA84000	
_.		DENITRIFICATION MIXER 1A LOADSHED	DO	16-CP-01	3	13	12	140DRA84000	
_.		DENITRIFICATION MIXER 1B RUN	DO	16-CP-01	3	13	13	140DRA84000	
_.		DENITRIFICATION MIXER 1B LOADSHED	DO	16-CP-01	3	13	14	140DRA84000	
_.		DENITRIFICATION MIXER 2A RUN	DO	16-CP-01	3	13	15	140DRA84000	

13400 APPENDIX B
EXISTING IO LIST

16-CP-01

TAG NAME	ALARM/STATUS RANGE	DESCRIPTIONS	I/O TYPE	PANEL/RTU LOCATION	RACK	SLOT	CHANNEL	MODULE #	REMARKS
_.									
_.		DENITRIFICATION MIXER 2A LOADSHED	DO	16-CP-01	3	14	0	140DRA84000	
_.		DENITRIFICATION MIXER 2B RUN	DO	16-CP-01	3	14	1	140DRA84000	
_.		DENITRIFICATION MIXER 2B LOADSHED	DO	16-CP-01	3	14	2	140DRA84000	
_.		AERATOR #1A PLC CALL COMMAND IF IN ASD AND REMOTE	DO	16-CP-01	3	14	3	140DRA84000	
_.		AERATOR #1A PLC CALL COMMAND IF IN BYPASS AND REMOTE	DO	16-CP-01	3	14	4	140DRA84000	
_.		AERATOR #1A LOADSHED	DO	16-CP-01	3	14	5	140DRA84000	
_.		AERATOR #1B PLC CALL COMMAND IF IN ASD AND REMOTE	DO	16-CP-01	3	14	6	140DRA84000	
_.		AERATOR #1B PLC CALL COMMAND IF IN BYPASS AND REMOTE	DO	16-CP-01	3	14	7	140DRA84000	
_.		AERATOR #1B LOADSHED	DO	16-CP-01	3	14	8	140DRA84000	
_.		AERATOR #2A PLC CALL COMMAND IF IN ASD AND REMOTE	DO	16-CP-01	3	14	9	140DRA84000	
_.		AERATOR #2A PLC CALL COMMAND IF IN BYPASS AND REMOTE	DO	16-CP-01	3	14	10	140DRA84000	
_.		AERATOR #2A LOADSHED	DO	16-CP-01	3	14	11	140DRA84000	
_.		AERATOR #2B PLC CALL COMMAND IF IN ASD AND REMOTE	DO	16-CP-01	3	14	12	140DRA84000	
_.		AERATOR #2B PLC CALL COMMAND IF IN BYPASS AND REMOTE	DO	16-CP-01	3	14	13	140DRA84000	
_.		AERATOR #2B LOADSHED	DO	16-CP-01	3	14	14	140DRA84000	
_.		ML PUMP #1 RUN COMMAND	DO	16-CP-01	3	14	15	140DRA84000	
_.									
_.		ML PUMP #1 LOADSHED	DO	16-CP-01	4	4	0	140DRA84000	
_.		ML PUMP #2 RUN COMMAND	DO	16-CP-01	4	4	1	140DRA84000	
_.		ML PUMP #2 LOADSHED	DO	16-CP-01	4	4	2	140DRA84000	
_.		ML PUMP #3 RUN COMMAND	DO	16-CP-01	4	4	3	140DRA84000	
_.		ML PUMP #3 LOADSHED	DO	16-CP-01	4	4	4	140DRA84000	
_.		SLUDGE HOLDING RUN COMMAND	DO	16-CP-01	4	4	5	140DRA84000	
_.		SLUDGE HOLDING LOADSHED	DO	16-CP-01	4	4	6	140DRA84000	
_.		SLUDGE BASIN MIXER #2 RUN COMMAND	DO	16-CP-01	4	4	7	140DRA84000	
_.		SLUDGE BASIN MIXER #2 LOADSHED	DO	16-CP-01	4	4	8	140DRA84000	
_.		SLUDGE BASIN MIXER #3 RUN COMMAND	DO	16-CP-01	4	4	9	140DRA84000	
_.		SLUDGE BASIN MIXER #3 LOADSHED	DO	16-CP-01	4	4	10	140DRA84000	
_.		IPS SUPPLY FAN LOADSHED	DO	16-CP-01	4	4	11	140DRA84000	
_.		IPS EXHAUST FAN LOADSHED	DO	16-CP-01	4	4	12	140DRA84000	
_.		DUMPSTER ROOM EXHAUST FAN LOADSHED	DO	16-CP-01	4	4	13	140DRA84000	
_.		SCREEN CHANNEL EXHAUST FAN #1 LOADSHED	DO	16-CP-01	4	4	14	140DRA84000	
_.		SCREEN CHANNEL EXHAUST FAN #2 LOADSHED	DO	16-CP-01	4	4	15	140DRA84000	
_.									
_.		GRIT PUMP/STORAGE ARE SUPPLY FAN LOADSHED	DO	16-CP-01	4	5	0	140DRA84000	
_.		GRIT PUMP/STORAGE ARE EXHAUST FAN LOADSHED	DO	16-CP-01	4	5	1	140DRA84000	
_.		ELECTRICAL ROOM SUPPLY FAN LOADSHED	DO	16-CP-01	4	5	2	140DRA84000	
_.		ELECTRICAL ROOM EXHAUST FAN LOADSHED	DO	16-CP-01	4	5	3	140DRA84000	
_.		UTILITY AIR COMPRESSORS LOADSHED	DO	16-CP-01	4	5	4	140DRA84000	
_.		ANNUNCIATOR ALARMING INFLUENT LEVEL ALARM	DO	16-CP-01	4	5	5	140DRA84000	
_.		ANNUNCIATOR ALARMING SCREEN SYSTEM #1 FAIL	DO	16-CP-01	4	5	6	140DRA84000	
_.		ANNUNCIATOR ALARMING SCREEN SYSTEM #2 FAIL	DO	16-CP-01	4	5	7	140DRA84000	
_.		ANNUNCIATOR ALARMING GRIT AGITATOR FAIL	DO	16-CP-01	4	5	8	140DRA84000	
_.		ANNUNCIATOR ALARMING GRIT PUMPS FAIL	DO	16-CP-01	4	5	9	140DRA84000	
_.		ANNUNCIATOR ALARMING GRIT CLASSIFIER FAIL	DO	16-CP-01	4	5	10	140DRA84000	
_.		ANNUNCIATOR ALARMING DENITE MIXER FAIL	DO	16-CP-01	4	5	11	140DRA84000	
_.		ANNUNCIATOR ALARMING OXIDATION DITCH FAIL	DO	16-CP-01	4	5	12	140DRA84000	
_.		ANNUNCIATOR ALARMING ML RECYCLE PUMPS FAIL	DO	16-CP-01	4	5	13	140DRA84000	
_.		ANNUNCIATOR ALARMING SLUDGE MIXERS FAIL	DO	16-CP-01	4	5	14	140DRA84000	
_.		ANNUNCIATOR ALARMING GENERATOR TROUBLE	DO	16-CP-01	4	5	15	140DRA84000	
_.									
_.		ANNUNCIATOR ALARMING 95% GENERATOR CAPACITY	DO	16-CP-01	4	6	0	140DRA84000	
_.		ANNUNCIATOR ALARMING COMMON ALARM	DO	16-CP-01	4	6	1	140DRA84000	
_.		ANNUNCIATOR ALARMING INFLUENT PUMP FAIL	DO	16-CP-01	4	6	2	140DRA84000	
_.		SPARE	DO	16-CP-01	4	6	3	140DRA84000	
_.		SPARE	DO	16-CP-01	4	6	4	140DRA84000	
_.		SPARE	DO	16-CP-01	4	6	5	140DRA84000	
_.		SPARE	DO	16-CP-01	4	6	6	140DRA84000	
_.		SPARE	DO	16-CP-01	4	6	7	140DRA84000	
_.		SPARE	DO	16-CP-01	4	6	8	140DRA84000	
_.		SPARE	DO	16-CP-01	4	6	9	140DRA84000	

13400 APPENDIX B
EXISTING IO LIST

16-CP-01

TAG NAME	ALARM/STATUS RANGE	DESCRIPTIONS	I/O TYPE	PANEL/RTU LOCATION	RACK	SLOT	CHANNEL	MODULE #	REMARKS
_.		SPARE	DO	16-CP-01	4	6	10	140DRA84000	
_.		SPARE	DO	16-CP-01	4	6	11	140DRA84000	
_.		SPARE	DO	16-CP-01	4	6	12	140DRA84000	
_.		SPARE	DO	16-CP-01	4	6	13	140DRA84000	
_.		SPARE	DO	16-CP-01	4	6	14	140DRA84000	
_.		SPARE	DO	16-CP-01	4	6	15	140DRA84000	
_.									
_.		WET WELL-1 INFLUENT WEL WELL LEVEL (BUBBLER) H20	AI	16-CP-01	4	9	0	140ACI04000	
_.		INFLUENT PUMP #1 SPEED INDICATION	AI	16-CP-01	4	9	1	140ACI04000	
_.		INFLUENT PUMP #2 SPEED INDICATION	AI	16-CP-01	4	9	2	140ACI04000	
_.		INFLUENT PUMP #3 SPEED INDICATION	AI	16-CP-01	4	9	3	140ACI04000	
_.		WET WELL-2 INFLUENT WEL WELL LEVEL (BUBBLER) H20	AI	16-CP-01	4	9	4	140ACI04000	
_.		INFLUENT PUMP #4 SPEED INDICATION	AI	16-CP-01	4	9	5	140ACI04000	
_.		INFLUENT PUMP #5 SPEED INDICATION	AI	16-CP-01	4	9	6	140ACI04000	
_.		SCREENINGS INLET LEVEL (BUBBLER)	AI	16-CP-01	4	9	7	140ACI04000	
_.		SCREENINGS INLET pH	AI	16-CP-01	4	9	8	140ACI04000	
_.		SCREENINGS OUTLET LEVEL (BUBBLER)	AI	16-CP-01	4	9	9	140ACI04000	
_.		SCREENINGS DIFFERENTIAL LEVEL ACROSS SCREEN 1 (BUBBLER)	AI	16-CP-01	4	9	10	140ACI04000	
_.		SCREENINGS DIFFERENTIAL LEVEL ACROSS SCREEN 2 (BUBBLER)	AI	16-CP-01	4	9	11	140ACI04000	
_.		GRIT AGITATOR PHARSHALL FLUME	AI	16-CP-01	4	9	12	140ACI04000	
_.		OXIDATION DITCH #1 DISSOLVED OXYGEN	AI	16-CP-01	4	9	13	140ACI04000	
_.		OXIDATION DITCH #1 DISSOLVED OXYGEN	AI	16-CP-01	4	9	14	140ACI04000	
_.		OXIDATION DITCH #2 DISSOLVED OXYGEN	AI	16-CP-01	4	9	15	140ACI04000	
_.									
_.		WET WELL-1 INFLUENT WET WELL LEVEL (BUBBLERS)	AI	16-CP-01	4	10	0	140ACI04000	
_.		WET WELL-2 INFLUENT WET WELL LEVEL (BUBBLERS)	AI	16-CP-01	4	10	1	140ACI04000	
_.		OXIDATION DITSCH #2 DISSOLVED OXYGEN	AI	16-CP-01	4	10	2	140ACI04000	
_.		AERATOR #1A AERATOR SPEED PLC SIGNAL	AI	16-CP-01	4	10	3	140ACI04000	
_.		AERATOR #1B AERATOR SPEED PLC SIGNAL	AI	16-CP-01	4	10	4	140ACI04000	
_.		AERATOR #2A AERATOR SPEED PLC SIGNAL	AI	16-CP-01	4	10	5	140ACI04000	
_.		AERATOR #2B AERATOR SPEED PLC SIGNAL	AI	16-CP-01	4	10	6	140ACI04000	
_.		SPARE	AI	16-CP-01	4	10	7	140ACI04000	
_.		SPARE	AI	16-CP-01	4	10	8	140ACI04000	
_.		SPARE	AI	16-CP-01	4	10	9	140ACI04000	
_.		SPARE	AI	16-CP-01	4	10	10	140ACI04000	
_.		SPARE	AI	16-CP-01	4	10	11	140ACI04000	
_.		SPARE	AI	16-CP-01	4	10	12	140ACI04000	
_.		SPARE	AI	16-CP-01	4	10	13	140ACI04000	
_.		SPARE	AI	16-CP-01	4	10	14	140ACI04000	
_.		SPARE	AI	16-CP-01	4	10	15	140ACI04000	
_.									
_.		INFLUENT PUMP #1 SPEED COMMAND PLC CONTROL OR HBS ACTIVE	AO	16-CP-01	4	13	0	140ACO13000	
_.		INFLUENT PUMP #2 SPEED COMMAND PLC CONTROL OR HBS ACTIVE	AO	16-CP-01	4	13	1	140ACO13000	
_.		INFLUENT PUMP #3 SPEED COMMAND PLC CONTROL	AO	16-CP-01	4	13	2	140ACO13000	
_.		INFLUENT PUMP #4 SPEED COMMAND PLC CONTROL OR HBS ACTIVE	AO	16-CP-01	4	13	3	140ACO13000	
_.		INFLUENT PUMP #5 SPEED COMMAND PLC CONTROL OR HBS ACTIVE	AO	16-CP-01	4	13	4	140ACO13000	
_.		SCREENINGS INLET SAMPLER PACES OFF OF INFLUENT FLOW FROM FIT-C5	AO	16-CP-01	4	13	5	140ACO13000	
_.		GRIT AGITATOR SAMPLER PACES OFF OF INFLUENT FLOW FROM FIT-C6	AO	16-CP-01	4	13	6	140ACO13000	
_.		AERATOR #1A SPEED COMMAND PLC CONTROL	AO	16-CP-01	4	13	7	140ACO13000	
_.									
_.		AERATOR #1B SPEED COMMAND PLC CONTROL	AO	16-CP-01	4	14	0	140ACO13000	
_.		AERATOR #2A SPEED COMMAND PLC CONTROL	AO	16-CP-01	4	14	1	140ACO13000	
_.		AERATOR #2B SPEED COMMAND PLC CONTROL	AO	16-CP-01	4	14	2	140ACO13000	
_.		SPARE	AO	16-CP-01	4	14	3	140ACO13000	
_.		SPARE	AO	16-CP-01	4	14	4	140ACO13000	
_.		SPARE	AO	16-CP-01	4	14	5	140ACO13000	
_.		SPARE	AO	16-CP-01	4	14	6	140ACO13000	
_.		SPARE	AO	16-CP-01	4	14	7	140ACO13000	
_.									
_.									
_.									

13400 APPENDIX B
EXISTING IO LIST

16-CP-01

TAG NAME	ALARM/STATUS RANGE	DESCRIPTIONS	I/O TYPE	PANEL/RTU LOCATION	RACK	SLOT	CHANNEL	MODULE #	REMARKS
_.									
		TOTAL I/O COUNT - AI:	**32**						
		DI:	**192**						
		DO:	**112**						
		AO:	**16**						

13400 APPENDIX B
EXISTING IO LIST

43-CP-01

TAG NAME	ALARM/STATUS RANGE	DESCRIPTIONS	I/O TYPE	PANEL/RTU LOCATION	RACK	SLOT	CHANNEL	MODULE #	REMARKS
_.		UPS TROUBLE	DI	43-CP-01	3	3	0	140DAI55300	
_.		24 VDC POWER OK	DI	43-CP-01	3	3	1	140DAI55300	
_.		SECONDARY CLARIFIER #1 32-CS-01 IN REMOTE	DI	43-CP-01	3	3	2	140DAI55300	
_.		SECONDARY CLARIFIER #1 32-CS-01 ON	DI	43-CP-01	3	3	3	140DAI55300	
_.		SECONDARY CLARIFIER #1 HIGH TORQUE ALARM TO ANNUNCIATOR	DI	43-CP-01	3	3	4	140DAI55300	
_.		SECONDARY CLARIFIER #1 HIGH HIGH TORQUE ALARM TO ANNUNCIATOR	DI	43-CP-01	3	3	5	140DAI55300	
_.		SECONDARY CLARIFIER #1 OVERLOAD ALARM TO ANNUNCIATOR	DI	43-CP-01	3	3	6	140DAI55300	
_.		SECONDARY CLARIFIER #2 32-CS-01 IN REMOTE	DI	43-CP-01	3	3	7	140DAI55300	
_.		SECONDARY CLARIFIER #2 32-CS-01 ON	DI	43-CP-01	3	3	8	140DAI55300	
_.		SECONDARY CLARIFIER #2 ON ALARM TO ANNUNCIATOR	DI	43-CP-01	3	3	9	140DAI55300	
_.		SECONDARY CLARIFIER #2 HIGH HIGH TORQUE ALARM TO ANNUNCIATOR	DI	43-CP-01	3	3	10	140DAI55300	
_.		SECONDARY CLARIFIER #2 OVERLOAD ALARM TO ANNUNCIATOR	DI	43-CP-01	3	3	11	140DAI55300	
_.		RAS PUMP #1 ASD IN BYPASS	DI	43-CP-01	3	3	12	140DAI55300	
_.		RAS PUMP #1 IN ASD	DI	43-CP-01	3	3	13	140DAI55300	
_.		RAS PUMP #1 33-CS-01 IN REMOTE	DI	43-CP-01	3	3	14	140DAI55300	
_.		RAS PUMP #1 ASD ON	DI	43-CP-01	3	3	15	140DAI55300	
_.		RAS PUMP #1 ASD BYPASS ON	DI	43-CP-01	3	3	16	140DAI55300	
_.		RAS PUMP #1 ASD FAIL	DI	43-CP-01	3	3	17	140DAI55300	
_.		RAS PUMP #2 ASD IN BYPASS	DI	43-CP-01	3	3	18	140DAI55300	
_.		RAS PUMP #2 AS IN ASD	DI	43-CP-01	3	3	19	140DAI55300	
_.		RAS PUMP #2 ASD IN REMOTE	DI	43-CP-01	3	3	20	140DAI55300	
_.		RAS PUMP #2 ASD ON	DI	43-CP-01	3	3	21	140DAI55300	
_.		RAS PUMP #2 ASD BYPASS ON	DI	43-CP-01	3	3	22	140DAI55300	
_.		RAS PUMP #2 ASD FAIL	DI	43-CP-01	3	3	23	140DAI55300	
_.		RAS PUMP #3 ASD IN BYPASS	DI	43-CP-01	3	3	24	140DAI55300	
_.		RAS PUMP #3 ASD IN ASD	DI	43-CP-01	3	3	25	140DAI55300	
_.		RAS PUMP #3 33-CS-01 IN REMOTE	DI	43-CP-01	3	3	26	140DAI55300	
_.		RAS PUMP #3 ASD ON	DI	43-CP-01	3	3	27	140DAI55300	
_.		RAS PUMP #3 ASD BYPASS ON	DI	43-CP-01	3	3	28	140DAI55300	
_.		RAS PUMP #3 ASD FAIL	DI	43-CP-01	3	3	29	140DAI55300	
_.		SCUM PIT MIXING BLOWER #1 33-CS-02 IN REMOTE	DI	43-CP-01	3	3	30	140DAI55300	
_.		SCUM PIT MIXING BLOWER #1 33-CS-02 BLOWER ON	DI	43-CP-01	3	3	31	140DAI55300	
_.									
_.		SCUM PIT MIXING BLOWER #1 33-CS-02 OVERLOAD	DI	43-CP-01	3	4	0	140DAI55300	
_.		SCUM PIT LEVEL MONITORING HIGH HIGH LEVEL SENSOR LSHH-H6	DI	43-CP-01	3	4	1	140DAI55300	
_.		SCUM PIT LEVEL MONITORING HIGH LEVEL SENSOR LSH-H6	DI	43-CP-01	3	4	2	140DAI55300	
_.		SCUM PIT LEVEL MONITORING MID LEVEL SENSOR LSM-H6	DI	43-CP-01	3	4	3	140DAI55300	
_.		SCUM PIT LEVEL MONITORING LOW LEVEL ALARM (LSL-H6)	DI	43-CP-01	3	4	4	140DAI55300	
_.		SECONDARY SCUM PUMP #1 IN REMOTE	DI	43-CP-01	3	4	5	140DAI55300	
_.		SECONDARY SCUM PUMP #1 PUMP ON	DI	43-CP-01	3	4	6	140DAI55300	
_.		SECONDARY SCUM PUMP #1 FAIL	DI	43-CP-01	3	4	7	140DAI55300	
_.		SECONDARY SCUM PUMP #1 HIGH PRESSURE (PSH-H7) TDR1-2	DI	43-CP-01	3	4	8	140DAI55300	
_.		SECONDARY SCUM PUMP #2 IN REMOTE	DI	43-CP-01	3	4	9	140DAI55300	
_.		SECONDARY SCUM PUMP #2 RUNNING	DI	43-CP-01	3	4	10	140DAI55300	
_.		SECONDARY SCUM PUMP #2 FAIL	DI	43-CP-01	3	4	11	140DAI55300	
_.		SECONDARY SCUM PUMP #2 HIGH PRESSURE (PSH-H8) TDR2-3	DI	43-CP-01	3	4	12	140DAI55300	
_.		SODIUM HYPOCHLORITE PUMP #6 IN REMOTE	DI	43-CP-01	3	4	13	140DAI55300	
_.		SODIUM HYPOCHLORITE PUMP #6 RUNNING	DI	43-CP-01	3	4	14	140DAI55300	
_.		SODIUM HYPOCHLORITE PUMP #6 FAIL	DI	43-CP-01	3	4	15	140DAI55300	
_.		SODIUM HYPOCHLORITE PUMP #7 IN REMOTE	DI	43-CP-01	3	4	16	140DAI55300	
_.		SODIUM HYPOCHLORITE PUMP #7 RUNNING	DI	43-CP-01	3	4	17	140DAI55300	
_.		SODIUM HYPOCHLORITE PUMP #7 FAIL	DI	43-CP-01	3	4	18	140DAI55300	
_.		RAS SUMP LEVEL HIGH HIGH	DI	43-CP-01	3	4	19	140DAI55300	
_.		RAS SUMP LEVEL HIGH	DI	43-CP-01	3	4	20	140DAI55300	
_.		RAS SUMP LEVEL LOW	DI	43-CP-01	3	4	21	140DAI55300	
_.		RAS SUMP LEVEL LOW LOW	DI	43-CP-01	3	4	22	140DAI55300	
_.		RAS STATION SUMP PUMP #1 IN REMOTE	DI	43-CP-01	3	4	23	140DAI55300	
_.		RAS STATION SUMP PUMP #1 RUNNING	DI	43-CP-01	3	4	24	140DAI55300	
_.		RAS STATION SUMP PUMP #1 OVERLOAD	DI	43-CP-01	3	4	25	140DAI55300	
_.		RAS STATION SUMP PUMP #2 IN REMOTE	DI	43-CP-01	3	4	26	140DAI55300	
_.		RAS STATION SUMP PUMP #2 RUNNING	DI	43-CP-01	3	4	27	140DAI55300	

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TAG NAME	ALARM/STATUS RANGE	DESCRIPTIONS	I/O TYPE	PANEL/RTU LOCATION	RACK	SLOT	CHANNEL	MODULE #	REMARKS
_.		RAS STATION SUMP PUMP #2 OVERLOAD	DI	43-CP-01	3	4	28	140DAI55300	
_.		FILTER PUMPING WEST WET WELL GATE LIMIT SWITCH OPEN	DI	43-CP-01	3	4	29	140DAI55300	
_.		FILTER PUMPING WEST WET WELL GATE LIMIT SWITCH CLOSED	DI	43-CP-01	3	4	30	140DAI55300	
_.		FILTER PUMPING EAST WET WELL GATE LIMIT SWITCH OPEN	DI	43-CP-01	3	4	31	140DAI55300	
_.									
_.		FILTER PUMPING EAST WET WELL GATE LIMIT SWITCH CLOSED	DI	43-CP-01	3	5	0	140DAI55300	
_.		FILTER FEED PUMP #2 ASD #1 IN BYPASS	DI	43-CP-01	3	5	1	140DAI55300	
_.		FILTER FEED PUMP #2 ASD #1 IN ASD	DI	43-CP-01	3	5	2	140DAI55300	
_.		FILTER FEED PUMP #2 61-LP-01 IN REMOTE	DI	43-CP-01	3	5	3	140DAI55300	
_.		FILTER FEED PUMP #2 ASD #1 ON	DI	43-CP-01	3	5	4	140DAI55300	
_.		FILTER FEED PUMP #2 ASD #1 BYPASS ON	DI	43-CP-01	3	5	5	140DAI55300	
_.		FILTER FEED PUMP #2 ASD #1 FAIL	DI	43-CP-01	3	5	6	140DAI55300	
_.		SPARE	DI	43-CP-01	3	5	7	140DAI55300	
_.		SPARE	DI	43-CP-01	3	5	8	140DAI55300	
_.		FILTER FEED PUMP #1 IN REMOTE	DI	43-CP-01	3	5	9	140DAI55300	
_.		FILTER FEED PUMP #1 ASD #2 ON	DI	43-CP-01	3	5	10	140DAI55300	
_.		SPARE	DI	43-CP-01	3	5	11	140DAI55300	
_.		FILTER FEED PUMP #1 ASD #2 FAIL	DI	43-CP-01	3	5	12	140DAI55300	
_.		FILTER FEED PUMP #3 ASD #3 IN BYPASS	DI	43-CP-01	3	5	13	140DAI55300	
_.		FILTER FEED PUMP #3 ASD #3 IN ASD	DI	43-CP-01	3	5	14	140DAI55300	
_.		FILTER FEED PUMP #3 61-LP-01 IN REMOTE	DI	43-CP-01	3	5	15	140DAI55300	
_.		FILTER FEED PUMP #3 ASD #3 ASD ON	DI	43-CP-01	3	5	16	140DAI55300	
_.		FILTER FEED PUMP #3 ASD #3 BYPASS ON	DI	43-CP-01	3	5	17	140DAI55300	
_.		FILTER FEED PUMP #3 ASD #3 ASD FAIL	DI	43-CP-01	3	5	18	140DAI55300	
_.		WEST WET WELL HIGH HIGH LEVEL	DI	43-CP-01	3	5	19	140DAI55300	
_.		WEST WET WELL LOW LOW LEVEL	DI	43-CP-01	3	5	20	140DAI55300	
_.		WEST WET WELL HBS-1 ACTIVE	DI	43-CP-01	3	5	21	140DAI55300	
_.		WEST WET WELL HBS ENABLE/DISABLE	DI	43-CP-01	3	5	22	140DAI55300	
_.		FILTER CHANNEL HIGH LEVEL	DI	43-CP-01	3	5	23	140DAI55300	
_.		FILTER CHANNEL HIGH HIGH LEVEL	DI	43-CP-01	3	5	24	140DAI55300	
_.		SPARE	DI	43-CP-01	3	5	25	140DAI55300	
_.		SPARE	DI	43-CP-01	3	5	26	140DAI55300	
_.		FILTER FEED PUMP #4 61-LP-01 IN REMOTE	DI	43-CP-01	3	5	27	140DAI55300	
_.		FILTER FEED PUMP #4 ASD #4 ASD ON	DI	43-CP-01	3	5	28	140DAI55300	
_.		SPARE	DI	43-CP-01	3	5	29	140DAI55300	
_.		FILTER FEED PUMP #4 ASD #4 ASD FAIL	DI	43-CP-01	3	5	30	140DAI55300	
_.		FILTER FEED PUMP #5 ASD #5 IN BYPASS	DI	43-CP-01	3	5	31	140DAI55300	
_.									
_.		FILTER FEED PUMP #5 ASD #5 IN ASD	DI	43-CP-01	3	6	0	140DAI55300	
_.		FILTER FEED PUMP #5 61-LP-01 IN REMOTE	DI	43-CP-01	3	6	1	140DAI55300	
_.		FILTER FEED PUMP #5 ASD #5 ASD ON	DI	43-CP-01	3	6	2	140DAI55300	
_.		FILTER FEED PUMP #5 ASD #5 BYPASS ON	DI	43-CP-01	3	6	3	140DAI55300	
_.		FILTER FEED PUMP #5 ASD #5 FAIL	DI	43-CP-01	3	6	4	140DAI55300	
_.		EAST WET WELL HIGH HIGH LEVEL	DI	43-CP-01	3	6	5	140DAI55300	
_.		EAST WET WELL LOW LOW LEVEL	DI	43-CP-01	3	6	6	140DAI55300	
_.		EAST WET WELL HBS-2 ACTIVE	DI	43-CP-01	3	6	7	140DAI55300	
_.		WEST WET WELL HIGH LEVEL (FUTURE)	DI	43-CP-01	3	6	8	140DAI55300	
_.		CHEMICAL INDUCTION UNIT #1 IN REMOTE (FUTURE)	DI	43-CP-01	3	6	9	140DAI55300	
_.		CHEMICAL INDUCTION UNIT #1 RUNNING	DI	43-CP-01	3	6	10	140DAI55300	
_.		CHEMICAL INDUCTION UNIT #1 FAIL	DI	43-CP-01	3	6	11	140DAI55300	
_.		CHEMICAL INDUCTION UNIT #2 IN REMOTE (FUTURE)	DI	43-CP-01	3	6	12	140DAI55300	
_.		CHEMICAL INDUCTION UNIT #2 RUNNING	DI	43-CP-01	3	6	13	140DAI55300	
_.		CHEMICAL INDUCTION UNIT #2 FAIL	DI	43-CP-01	3	6	14	140DAI55300	
_.		FINAL EFFLUENT DECHLORINATION SAMPLE IN PROGRESS	DI	43-CP-01	3	6	15	140DAI55300	
_.		EFFLUENT GATE CONTROL OPEN LIMIT SWITCH (ZSH-K6-1)	DI	43-CP-01	3	6	16	140DAI55300	
_.		EFFLUENT GATE CONTROL CLOSED LIMIT SWITCH (ZSL-K6-1)	DI	43-CP-01	3	6	17	140DAI55300	
_.		EFFLUENT GATE CONTROL OPEN LIMIT SWITCH (ZSH-K6-2)	DI	43-CP-01	3	6	18	140DAI55300	
_.		EFFLUENT GATE CONTROL CLOSED LIMIT SWITCH (ZSL-K6-2)	DI	43-CP-01	3	6	19	140DAI55300	
_.		UTILITY WATER PUMPING LOW LEVEL	DI	43-CP-01	3	6	20	140DAI55300	
_.		UTILITY WATER PUMP #1 IN REMOTE	DI	43-CP-01	3	6	21	140DAI55300	
_.		UTILITY WATER PUMP #1 PUMP ON	DI	43-CP-01	3	6	22	140DAI55300	
_.		UTILITY WATER PUMP #1 OVERLOAD	DI	43-CP-01	3	6	23	140DAI55300	
_.		UTILITY WATER PUMP #1 HIGH PRESSURE (TDR3-1)	DI	43-CP-01	3	6	24	140DAI55300	

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EXISTING IO LIST

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TAG NAME	ALARM/STATUS RANGE	DESCRIPTIONS	I/O TYPE	PANEL/RTU LOCATION	RACK	SLOT	CHANNEL	MODULE #	REMARKS
_.		UTILITY WATER PUMP #1 HIGH TEMP	DI	43-CP-01	3	6	25	140DAI55300	
_.		UTILITY WATER PUMP #2 PUMP ON	DI	43-CP-01	3	6	26	140DAI55300	
_.		UTILITY WATER PUMP #2 OVERLOAD	DI	43-CP-01	3	6	27	140DAI55300	
_.		UTILITY WATER PUMP #2 HIGH PRESSURE (TDR4-1)	DI	43-CP-01	3	6	28	140DAI55300	
_.		UTILITY WATER PUMP #3 IN REMOTE	DI	43-CP-01	3	6	29	140DAI55300	
_.		UTILITY WATER PUMP #3 ON	DI	43-CP-01	3	6	30	140DAI55300	
_.		UTILITY WATER PUMP #3 FAIL	DI	43-CP-01	3	6	31	140DAI55300	
_.									
_.		UTILITY WATER PUMP #3 HIGH PRESSURE (TDR5-1)	DI	43-CP-01	3	7	0	140DAI55300	
_.		COMPRESSOR #1 ON	DI	43-CP-01	3	7	1	140DAI55300	
_.		COMPRESSOR #2 ON	DI	43-CP-01	3	7	2	140DAI55300	
_.		COMPRESSOR FAIL	DI	43-CP-01	3	7	3	140DAI55300	
_.		UTILITY WATER PUMPING PRESSURE LOW	DI	43-CP-01	3	7	4	140DAI55300	
_.		UTILITY WATER PUMPING PRESSURE HIGH HIGH	DI	43-CP-01	3	7	5	140DAI55300	
_.		UTILITY WATER PUMPING PRESSURE HIGH	DI	43-CP-01	3	7	6	140DAI55300	
_.		UTILITY WATER PUMPING PRESSURE LOW	DI	43-CP-01	3	7	7	140DAI55300	
_.		UTILITY WATER PUMPING PRESSURE LOW LOW	DI	43-CP-01	3	7	8	140DAI55300	
_.		RECLAIM WATER VALVE IN REMOTE	DI	43-CP-01	3	7	9	140DAI55300	
_.		SODIUM HYPOCHLORITE PUMP #1 IN REMOTE	DI	43-CP-01	3	7	10	140DAI55300	
_.		SODIUM HYPOCHLORITE PUMP #1 ON	DI	43-CP-01	3	7	11	140DAI55300	
_.		SODIUM HYPOCHLORITE PUMP #1 FAIL	DI	43-CP-01	3	7	12	140DAI55300	
_.		SODIUM HYPOCHLORITE PUMP #2 IN REMOTE	DI	43-CP-01	3	7	13	140DAI55300	
_.		SODIUM HYPOCHLORITE PUMP #2 ON	DI	43-CP-01	3	7	14	140DAI55300	
_.		SODIUM HYPOCHLORITE PUMP #2 FAIL	DI	43-CP-01	3	7	15	140DAI55300	
_.		SODIUM HYPOCHLORITE PUMP #3 IN REMOTE	DI	43-CP-01	3	7	16	140DAI55300	
_.		SODIUM HYPOCHLORITE PUMP #3 ON	DI	43-CP-01	3	7	17	140DAI55300	
_.		SODIUM HYPOCHLORITE PUMP #3 FAIL	DI	43-CP-01	3	7	18	140DAI55300	
_.		SODIUM HYPOCHLORITE PUMP #4 IN REMOTE	DI	43-CP-01	3	7	19	140DAI55300	
_.		SODIUM HYPOCHLORITE PUMP #4 ON	DI	43-CP-01	3	7	20	140DAI55300	
_.		SODIUM HYPOCHLORITE PUMP #4 FAIL	DI	43-CP-01	3	7	21	140DAI55300	
_.		SODIUM HYPOCHLORITE PUMP #5 IN REMOTE	DI	43-CP-01	3	7	22	140DAI55300	
_.		SODIUM HYPOCHLORITE PUMP #5 ON	DI	43-CP-01	3	7	23	140DAI55300	
_.		SODIUM HYPOCHLORITE PUMP #5 FAIL	DI	43-CP-01	3	7	24	140DAI55300	
_.		CHEMICAL ROOM SUMP PUMP LEVEL HIGH	DI	43-CP-01	3	7	25	140DAI55300	
_.		CHEMICAL ROOM SUMP PUMP IN REMOTE	DI	43-CP-01	3	7	26	140DAI55300	
_.		CHEMICAL ROOM SUMP PUMP ON	DI	43-CP-01	3	7	27	140DAI55300	
_.		CHEMICAL ROOM SUMP PUMP OVERLOAD	DI	43-CP-01	3	7	28	140DAI55300	
_.		SODIUM BISULFITE PUMP #1 IN REMOTE	DI	43-CP-01	3	7	29	140DAI55300	
_.		SODIUM BISULFITE PUMP #1 ON	DI	43-CP-01	3	7	30	140DAI55300	
_.		SODIUM BISULFITE PUMP #1 FAIL	DI	43-CP-01	3	7	31	140DAI55300	
_.									
_.		SODIUM BISULFITE PUMP #2 IN REMOTE	DI	43-CP-01	3	8	0	140DAI55300	
_.		SODIUM BISULFITE PUMP #2 ON	DI	43-CP-01	3	8	1	140DAI55300	
_.		SODIUM BISULFITE PUMP #2 FAIL	DI	43-CP-01	3	8	2	140DAI55300	
_.		ALUM FEED PUMP #1 IN REMOTE	DI	43-CP-01	3	8	3	140DAI55300	
_.		ALUM FEED PUMP #1 ON	DI	43-CP-01	3	8	4	140DAI55300	
_.		ALUM FEED PUMP #1 FAIL	DI	43-CP-01	3	8	5	140DAI55300	
_.		ALUM FEED PUMP #2 IN REMOTE	DI	43-CP-01	3	8	6	140DAI55300	
_.		ALUM FEED PUMP #2 ON	DI	43-CP-01	3	8	7	140DAI55300	
_.		ALUM FEED PUMP #2 FAIL	DI	43-CP-01	3	8	8	140DAI55300	
_.		POLYMER MIX FEED PUMP #1 IN REMOTE	DI	43-CP-01	3	8	9	140DAI55300	
_.		POLYMER MIX FEED PUMP #1 ON	DI	43-CP-01	3	8	10	140DAI55300	
_.		POLYMER MIX FEED PUMP #1 FAIL	DI	43-CP-01	3	8	11	140DAI55300	
_.		POLYMER MIX FEED PUMP #2 IN REMOTE	DI	43-CP-01	3	8	12	140DAI55300	
_.		POLYMER MIX FEED PUMP #2 ON	DI	43-CP-01	3	8	13	140DAI55300	
_.		POLYMER MIX FEED PUMP #2 FAIL	DI	43-CP-01	3	8	14	140DAI55300	
_.		ELECTRICAL ROOM SUPPLY FAN 43-F-01-FA ON	DI	43-CP-01	3	8	15	140DAI55300	
_.		ELECTRICAL ROOM EXHAUST FAN 43-F-02-FA ON	DI	43-CP-01	3	8	16	140DAI55300	
_.		BLOWER ROOM EXHAUST FAN 42-F-01-FA ON	DI	43-CP-01	3	8	17	140DAI55300	
_.		RAS PUMP STATION SUPPLY FAN #1 33-F-01-FA ON	DI	43-CP-01	3	8	18	140DAI55300	
_.		RAS PUMP STATION EXHAUST FAN #1 33-F-02-FA ON	DI	43-CP-01	3	8	19	140DAI55300	
_.		RAS PUMP STATION EXHAUST FAN #2 33-F-03-FA ON	DI	43-CP-01	3	8	20	140DAI55300	
_.		CHEMICAL ROOM SUPPLY FAN 44-F-01-FA ON	DI	43-CP-01	3	8	21	140DAI55300	

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EXISTING IO LIST

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TAG NAME	ALARM/STATUS RANGE	DESCRIPTIONS	I/O TYPE	PANEL/RTU LOCATION	RACK	SLOT	CHANNEL	MODULE #	REMARKS
_.		CHEMICAL ROOM EXHAUST FAN 44-F-02-FA ON	DI	43-CP-01	3	8	22	140DAI55300	
_.		CHEM COMPLEX EMERGENCY EYEWASH IN USE (FSH-T2-2)	DI	43-CP-01	3	8	23	140DAI55300	
_.		CHEM COMPLEX EMERGENCY EYEWASH IN USE (FSH-T2-3)	DI	43-CP-01	3	8	24	140DAI55300	
_.		CHEM COMPLEX EMERGENCY EYEWASH IN USE (FSH-T2-4)	DI	43-CP-01	3	8	25	140DAI55300	
_.		FILTER FEED PUMPS #1, 2 & 3 STOP PUMPS	DI	43-CP-01	3	8	26	140DAI55300	
_.		FILTER FEED PUMPS #1, 2 & 3 RUN PUMP #1	DI	43-CP-01	3	8	27	140DAI55300	
_.		FILTER FEED PUMPS #1, 2 & 3 RUN PUMP #2	DI	43-CP-01	3	8	28	140DAI55300	
_.		FILTER FEED PUMPS #4 & 5 STOP BOTH PUMPS	DI	43-CP-01	3	8	29	140DAI55300	
_.		FILTER FEED PUMPS #4 & 5 START PUMP #4	DI	43-CP-01	3	8	30	140DAI55300	
_.		FILTER FEED PUMPS #4 & 5 START PUMP #5	DI	43-CP-01	3	8	31	140DAI55300	
_.									
_.		REFRIGERATED SAMPLER SAMPLE IN PROGRESS	DI	43-CP-01	3	9	0	140DAI55300	
_.		SPARE	DI	43-CP-01	3	9	1	140DAI55300	
_.		SPARE	DI	43-CP-01	3	9	2	140DAI55300	
_.		SPARE	DI	43-CP-01	3	9	3	140DAI55300	
_.		SPARE	DI	43-CP-01	3	9	4	140DAI55300	
_.		SPARE	DI	43-CP-01	3	9	5	140DAI55300	
_.		SPARE	DI	43-CP-01	3	9	6	140DAI55300	
_.		SPARE	DI	43-CP-01	3	9	7	140DAI55300	
_.		SPARE	DI	43-CP-01	3	9	8	140DAI55300	
_.		SPARE	DI	43-CP-01	3	9	9	140DAI55300	
_.		SPARE	DI	43-CP-01	3	9	10	140DAI55300	
_.		SPARE	DI	43-CP-01	3	9	11	140DAI55300	
_.		SPARE	DI	43-CP-01	3	9	12	140DAI55300	
_.		SPARE	DI	43-CP-01	3	9	13	140DAI55300	
_.		SPARE	DI	43-CP-01	3	9	14	140DAI55300	
_.		SPARE	DI	43-CP-01	3	9	15	140DAI55300	
_.		SPARE	DI	43-CP-01	3	9	16	140DAI55300	
_.		SPARE	DI	43-CP-01	3	9	17	140DAI55300	
_.		SPARE	DI	43-CP-01	3	9	18	140DAI55300	
_.		SPARE	DI	43-CP-01	3	9	19	140DAI55300	
_.		SPARE	DI	43-CP-01	3	9	20	140DAI55300	
_.		SPARE	DI	43-CP-01	3	9	21	140DAI55300	
_.		SPARE	DI	43-CP-01	3	9	22	140DAI55300	
_.		SPARE	DI	43-CP-01	3	9	23	140DAI55300	
_.		SPARE	DI	43-CP-01	3	9	24	140DAI55300	
_.		SPARE	DI	43-CP-01	3	9	25	140DAI55300	
_.		SPARE	DI	43-CP-01	3	9	26	140DAI55300	
_.		SPARE	DI	43-CP-01	3	9	27	140DAI55300	
_.		SPARE	DI	43-CP-01	3	9	28	140DAI55300	
_.		SPARE	DI	43-CP-01	3	9	29	140DAI55300	
_.		SPARE	DI	43-CP-01	3	9	30	140DAI55300	
_.		SPARE	DI	43-CP-01	3	9	31	140DAI55300	
_.									
_.		SECONDARY CLARIFIER #1 IN REMOTE	DO	43-CP-01	3	11	0	140DRA84000	
_.		SECONDARY CLARIFIER #1 LOADSHED	DO	43-CP-01	3	11	1	140DRA84000	
_.		SECONDARY CLARIFIER #2 IN REMOTE	DO	43-CP-01	3	11	2	140DRA84000	
_.		SECONDARY CLARIFIER #2 LOADSHED	DO	43-CP-01	3	11	3	140DRA84000	
_.		RAS PUMP #1 PLC CALL COMMAND IF IN ASD AND REMOTE	DO	43-CP-01	3	11	4	140DRA84000	
_.		RAS PUMP #1 PLC CALL COMMAND IF IN BYPASS AND REMOTE	DO	43-CP-01	3	11	5	140DRA84000	
_.		RAS PUMP #1 LOADSHED	DO	43-CP-01	3	11	6	140DRA84000	
_.		RAS PUMP #2 PLC CALL COMMAND IF IN ASD AND REMOTE	DO	43-CP-01	3	11	7	140DRA84000	
_.		RAS PUMP #2 PLC CALL COMMAND IF IN BYPASS AND REMOTE	DO	43-CP-01	3	11	8	140DRA84000	
_.		RAS PUMP #2 LOADSHED	DO	43-CP-01	3	11	9	140DRA84000	
_.		RAS PUMP #3 PLC CALL COMMAND IF IN ASD AND REMOTE	DO	43-CP-01	3	11	10	140DRA84000	
_.		RAS PUMP #3 PLC CALL COMMAND IF IN BYPASS AND REMOTE	DO	43-CP-01	3	11	11	140DRA84000	
_.		RAS PUMP #3 LOADSHED	DO	43-CP-01	3	11	12	140DRA84000	
_.		SCUM PIT MIXING BLOWER #1 RUN COMMAND	DO	43-CP-01	3	11	13	140DRA84000	
_.		SCUM PIT MIXING BLOWER #1 LOADSHED	DO	43-CP-01	3	11	14	140DRA84000	
_.		SECONDARY SCUM PUMP #1 RUN COMMAND	DO	43-CP-01	3	11	15	140DRA84000	
_.									
_.		SECONDARY SCUM PUMP #1 LOADSHED	DO	43-CP-01	3	12	0	140DRA84000	
_.		SECONDARY SCUM PUMP #2 RUN COMMAND	DO	43-CP-01	3	12	1	140DRA84000	

13400 APPENDIX B
EXISTING IO LIST

43-CP-01

TAG NAME	ALARM/STATUS RANGE	DESCRIPTIONS	I/O TYPE	PANEL/RTU LOCATION	RACK	SLOT	CHANNEL	MODULE #	REMARKS
_.		SECONDARY SCUM PUMP #2 LOADSHED	DO	43-CP-01	3	12	2	140DRA84000	
_.		UTILITY WATER AIR VALVE OPEN COMMAND	DO	43-CP-01	3	12	3	140DRA84000	
_.		SODIUM HYPOCHLORITE PUMP #6 RUN COMMAND	DO	43-CP-01	3	12	4	140DRA84000	
_.		SODIUM HYPOCHLORITE PUMP #6 LOADSHED	DO	43-CP-01	3	12	5	140DRA84000	
_.		SODIUM HYPOCHLORITE PUMP #7 RUN COMMAND	DO	43-CP-01	3	12	6	140DRA84000	
_.		RAS STATION SUMP PUMP #1 RUN COMMAND	DO	43-CP-01	3	12	7	140DRA84000	
_.		RAS STATION SUMP PUMP #1 LOADSHED	DO	43-CP-01	3	12	8	140DRA84000	
_.		RAS STATION SUMP PUMP #2 RUN COMMAND	DO	43-CP-01	3	12	9	140DRA84000	
_.		RAS STATION SUMP PUMP #2 LOADSHED	DO	43-CP-01	3	12	10	140DRA84000	
_.		FILTER FEED PUMP #2 PLC CALL COMMAND IF IN ASD AND REMOTE	DO	43-CP-01	3	12	11	140DRA84000	
_.		FILTER FEED PUMP #2 PLC CALL COMMAND IF IN BYPASS AND REMOTE	DO	43-CP-01	3	12	12	140DRA84000	
_.		FILTER FEED PUMP #2 LOADSHED	DO	43-CP-01	3	12	13	140DRA84000	
_.		FILTER FEED PUMP #1 PLC CALL COMMAND IF IN ASD AND REMOTE	DO	43-CP-01	3	12	14	140DRA84000	
_.		SPACE	DO	43-CP-01	3	12	15	140DRA84000	
_.									
_.		FILTER FEED PUMP #1 LOADSHED	DO	43-CP-01	3	13	0	140DRA84000	
_.		FILTER FEED PUMP #3 PLC CALL COMMAND IF IN ASD AND REMOTE	DO	43-CP-01	3	13	1	140DRA84000	
_.		FILTER FEED PUMP #3 PLC CALL COMMAND IF IN BYPASS AND REMOTE	DO	43-CP-01	3	13	2	140DRA84000	
_.		FILTER FEED PUMP #3 LOADSHED	DO	43-CP-01	3	13	3	140DRA84000	
_.		FILTER FEED PUMP #4 PLC CALL COMMAND IF IN ASD AND REMOTE	DO	43-CP-01	3	13	4	140DRA84000	
_.		SPARE	DO	43-CP-01	3	13	5	140DRA84000	
_.		FILTER FEED PUMP #4 LOADSHED	DO	43-CP-01	3	13	6	140DRA84000	
_.		FILTER FEED PUMP #5 PLC CALL COMMAND IF IN ASD AND REMOTE	DO	43-CP-01	3	13	7	140DRA84000	
_.		FILTER FEED PUMP #5 PLC CALL COMMAND IF IN BYPASS AND REMOTE	DO	43-CP-01	3	13	8	140DRA84000	
_.		FILTER FEED PUMP #5 LOADSHED	DO	43-CP-01	3	13	9	140DRA84000	
_.		CHEMICAL INDUCTION UNIT #1 RUN COMMAND	DO	43-CP-01	3	13	10	140DRA84000	
_.		CHEMICAL INDUCTION UNIT #1 LOADSHED	DO	43-CP-01	3	13	11	140DRA84000	
_.		CHEMICAL INDUCTION UNIT #2 RUN COMMAND	DO	43-CP-01	3	13	12	140DRA84000	
_.		CHEMICAL INDUCTION UNIT #2 LOADSHED	DO	43-CP-01	3	13	13	140DRA84000	
_.		UTILITY WATER PUMP #1 RUN COMMAND	DO	43-CP-01	3	13	14	140DRA84000	
_.		UTILITY WATER PUMP #1 LOADSHED	DO	43-CP-01	3	13	15	140DRA84000	
_.									
_.		UTILITY WATER PUMP #2 RUN COMMAND	DO	43-CP-01	3	14	0	140DRA84000	
_.		UTILITY WATER PUMP #2 LOADSHED	DO	43-CP-01	3	14	1	140DRA84000	
_.		UTILITY WATER PUMP #3 RUN COMMAND	DO	43-CP-01	3	14	2	140DRA84000	
_.		UTILITY WATER PUMP #3 LOADSHED	DO	43-CP-01	3	14	3	140DRA84000	
_.		COMPRESSOR 42-ME-01/02-A LOADSHED	DO	43-CP-01	3	14	4	140DRA84000	
_.		RECLAIM WATER VALVE OPEN COMMAND	DO	43-CP-01	3	14	5	140DRA84000	
_.		RECLAIM WATER VALVE CLOSE COMMAND	DO	43-CP-01	3	14	6	140DRA84000	
_.		SODIUM HYPOCHLORITE PUMP #1 RUN COMMAND	DO	43-CP-01	3	14	7	140DRA84000	
_.		SODIUM HYPOCHLORITE PUMP #1 LOADSHED	DO	43-CP-01	3	14	8	140DRA84000	
_.		SODIUM HYPOCHLORITE PUMP #2 RUN COMMAND	DO	43-CP-01	3	14	9	140DRA84000	
_.		SODIUM HYPOCHLORITE PUMP #2 LOADSHED	DO	43-CP-01	3	14	10	140DRA84000	
_.		SODIUM HYPOCHLORITE PUMP #3 RUN COMMAND	DO	43-CP-01	3	14	11	140DRA84000	
_.		SODIUM HYPOCHLORITE PUMP #3 LOADSHED	DO	43-CP-01	3	14	12	140DRA84000	
_.		SODIUM HYPOCHLORITE PUMP #4 RUN COMMAND	DO	43-CP-01	3	14	13	140DRA84000	
_.		SODIUM HYPOCHLORITE PUMP #4 LOADSHED	DO	43-CP-01	3	14	14	140DRA84000	
_.		SODIUM HYPOCHLORITE PUMP #5 RUN COMMAND	DO	43-CP-01	3	14	15	140DRA84000	
_.									
_.		SODIUM HYPOCHLORITE PUMP #5 LOADSHED	DO	43-CP-01	3	15	0	140DRA84000	
_.		CHEMICAL ROOM SUMP PUMP RUN COMMAND	DO	43-CP-01	3	15	1	140DRA84000	
_.		CHEMICAL ROOM SUMP PUMP LOADSHED	DO	43-CP-01	3	15	2	140DRA84000	
_.		SODIUM BISULFITE PUMP #1 RUN COMMAND	DO	43-CP-01	3	15	3	140DRA84000	
_.		SODIUM BISULFITE PUMP #1 LOADSHED	DO	43-CP-01	3	15	4	140DRA84000	
_.		SODIUM BISULFITE PUMP #2 RUN COMMAND	DO	43-CP-01	3	15	5	140DRA84000	
_.		SODIUM BISULFITE PUMP #2 LOADSHED	DO	43-CP-01	3	15	6	140DRA84000	
_.		ALUM FEED PUMP #1 RUN COMMAND	DO	43-CP-01	3	15	7	140DRA84000	
_.		ALUM FEED PUMP #1 LOADSHED	DO	43-CP-01	3	15	8	140DRA84000	
_.		ALUM FEED PUMP #2 RUN COMMAND	DO	43-CP-01	3	15	9	140DRA84000	
_.		ALUM FEED PUMP #2 LOADSHED	DO	43-CP-01	3	15	10	140DRA84000	
_.		POLYMER MIX FEED PUMP #1 RUN COMMAND	DO	43-CP-01	3	15	11	140DRA84000	
_.		POLYMER MIX FEED PUMP #1 LOADSHED	DO	43-CP-01	3	15	12	140DRA84000	
_.		POLYMER MIX FEED PUMP #2 RUN COMMAND	DO	43-CP-01	3	15	13	140DRA84000	

13400 APPENDIX B
EXISTING IO LIST

43-CP-01

TAG NAME	ALARM/STATUS RANGE	DESCRIPTIONS	I/O TYPE	PANEL/RTU LOCATION	RACK	SLOT	CHANNEL	MODULE #	REMARKS
_.		POLYMER MIX FEED PUMP #2 LOADSHED	DO	43-CP-01	3	15	14	140DRA84000	
_.		RAS PUMP STATION SUPPLY FAN #1 LOADSHED	DO	43-CP-01	3	15	15	140DRA84000	
_.									
_.		COMMON ALARMS	DO	43-CP-01	4	4	0	140DRA84000	
_.		ANNUNCIATOR ALARMING-CLARIFIERS FAIL	DO	43-CP-01	4	4	1	140DRA84000	
_.		ANNUNCIATOR ALARMING-RAS PUMP FAIL	DO	43-CP-01	4	4	2	140DRA84000	
_.		ANNUNCIATOR ALARMING-RAS PUMP STATION SUMP FAIL	DO	43-CP-01	4	4	3	140DRA84000	
_.		ANNUNCIATOR ALARMING-FILTER PUMPING FAIL	DO	43-CP-01	4	4	4	140DRA84000	
_.		ANNUNCIATOR ALARMING-UTILITY WATER PUMPS FAIL	DO	43-CP-01	4	4	5	140DRA84000	
_.		ANNUNCIATOR ALARMING-HYPOCHLORITE PUMP FAIL	DO	43-CP-01	4	4	6	140DRA84000	
_.		ANNUNCIATOR ALARMING-CHEMICAL ROOM SUMP PUMP FAIL	DO	43-CP-01	4	4	7	140DRA84000	
_.		ANNUNCIATOR ALARMING-SODIUM BISULFITE PUMP FAIL	DO	43-CP-01	4	4	8	140DRA84000	
_.		ANNUNCIATOR ALARMING-ALUM FEED PUMP FAIL	DO	43-CP-01	4	4	9	140DRA84000	
_.		ANNUNCIATOR ALARMING-POLYMER MIX FEED PUMPS FAIL	DO	43-CP-01	4	4	10	140DRA84000	
_.		ANNUNCIATOR ALARMING-SCUMP PUMPING FAIL	DO	43-CP-01	4	4	11	140DRA84000	
_.		SODIUM HYPOCHLORITE PUMP #7 LOADSHED	DO	43-CP-01	4	4	12	140DRA84000	
_.		SPARE	DO	43-CP-01	4	4	13	140DRA84000	
_.		SPARE	DO	43-CP-01	4	4	14	140DRA84000	
_.		SPARE	DO	43-CP-01	4	4	15	140DRA84000	
_.									
_.		SPARE	DO	43-CP-01	4	5	0	140DRA84000	
_.		SPARE	DO	43-CP-01	4	5	1	140DRA84000	
_.		SPARE	DO	43-CP-01	4	5	2	140DRA84000	
_.		SPARE	DO	43-CP-01	4	5	3	140DRA84000	
_.		SPARE	DO	43-CP-01	4	5	4	140DRA84000	
_.		SPARE	DO	43-CP-01	4	5	5	140DRA84000	
_.		SPARE	DO	43-CP-01	4	5	6	140DRA84000	
_.		SPARE	DO	43-CP-01	4	5	7	140DRA84000	
_.		SPARE	DO	43-CP-01	4	5	8	140DRA84000	
_.		SPARE	DO	43-CP-01	4	5	9	140DRA84000	
_.		SPARE	DO	43-CP-01	4	5	10	140DRA84000	
_.		SPARE	DO	43-CP-01	4	5	11	140DRA84000	
_.		SPARE	DO	43-CP-01	4	5	12	140DRA84000	
_.		SPARE	DO	43-CP-01	4	5	13	140DRA84000	
_.		SPARE	DO	43-CP-01	4	5	14	140DRA84000	
_.		SPARE	DO	43-CP-01	4	5	15	140DRA84000	
_.									
_.		SECONDARY CLARIFIER #2 FLOW	AI	43-CP-01	4	7	0	140ACI04000	
_.		SECONDARY CLARIFIER #1 FLOW	AI	43-CP-01	4	7	1	140ACI04000	
_.		RAS PUMP #1 SPEED FEEDBACK	AI	43-CP-01	4	7	2	140ACI04000	
_.		RAS PUMP #2 SPEED FEEDBACK	AI	43-CP-01	4	7	3	140ACI04000	
_.		RAS PUMP #3 SPEED FEEDBACK	AI	43-CP-01	4	7	4	140ACI04000	
_.		SECONDARY SCUM PUMP #1 SPEED FEEDBACK	AI	43-CP-01	4	7	5	140ACI04000	
_.		SECONDARY SCUM PUMP #2 SPEED FEEDBACK	AI	43-CP-01	4	7	6	140ACI04000	
_.		WEST WET WELL LEVEL	AI	43-CP-01	4	7	7	140ACI04000	
_.		FILTER FEED PUMP #1 SPEED FEEDBACK	AI	43-CP-01	4	7	8	140ACI04000	
_.		FILTER FEED PUMP #2 SPEED FEEDBACK	AI	43-CP-01	4	7	9	140ACI04000	
_.		FILTER FEED PUMP #3 SPEED FEEDBACK	AI	43-CP-01	4	7	10	140ACI04000	
_.		EAST WET WELL LEVEL	AI	43-CP-01	4	7	11	140ACI04000	
_.		FILTER FEED PUMP #4 SPEED FEEDBACK	AI	43-CP-01	4	7	12	140ACI04000	
_.		FILTER FEED PUMP #5 SPEED FEEDBACK	AI	43-CP-01	4	7	13	140ACI04000	
_.		POND FLOW	AI	43-CP-01	4	7	14	140ACI04000	
_.		CHLORINE RESIDUAL ANALYZER	AI	43-CP-01	4	7	15	140ACI04000	
_.									
_.		FILTERED EFFLUENT FLOW	AI	43-CP-01	4	8	0	140ACI04000	
_.		FINAL EFFLUENT FLOW	AI	43-CP-01	4	8	1	140ACI04000	
_.		FINAL EFFLUENT CHLORINE RESIDUAL	AI	43-CP-01	4	8	2	140ACI04000	
_.		FINAL EFFLUENT CHLORINE RESIDUAL TURBIDITY	AI	43-CP-01	4	8	3	140ACI04000	
_.		FINAL EFFLUENT DECHLORINATION	AI	43-CP-01	4	8	4	140ACI04000	
_.		FINAL EFFLUENT DECHLORINATION pH	AI	43-CP-01	4	8	5	140ACI04000	
_.		FINAL EFFLUENT DECHLORINATION CONDUCTIVITY	AI	43-CP-01	4	8	6	140ACI04000	
_.		CASCADE AERATOR DISSOLVED OXYGEN LEVEL	AI	43-CP-01	4	8	7	140ACI04000	
_.		CASCADE AERATOR TEMPERATURE	AI	43-CP-01	4	8	8	140ACI04000	

13400 APPENDIX B
EXISTING IO LIST

43-CP-01

TAG NAME	ALARM/STATUS RANGE	DESCRIPTIONS	I/O TYPE	PANEL/RTU LOCATION	RACK	SLOT	CHANNEL	MODULE #	REMARKS
_.		UTILITY WATER PUMPING PRESSURE	AI	43-CP-01	4	8	9	140ACI04000	
_.		RECLAIM WATER VALVE FLOW (FIT M3-1)	AI	43-CP-01	4	8	10	140ACI04000	
_.		RECLAIM WATER VALVE FLOW (FIT M3-2)	AI	43-CP-01	4	8	11	140ACI04000	
_.		RECLAIMED WATER CL2 RESIDUAL	AI	43-CP-01	4	8	12	140ACI04000	
_.		RECLAIMED WATER VALVE GATE POSITION	AI	43-CP-01	4	8	13	140ACI04000	
_.		SODIUM HYPOCHLORITE TANK LEVEL	AI	43-CP-01	4	8	14	140ACI04000	
_.		SODIUM BISULFITE TANK LEVEL	AI	43-CP-01	4	8	15	140ACI04000	
_.									
_.		ALUM TANK LEVEL	AI	43-CP-01	4	9	0	140ACI04000	
_.		FINAL EFFLUENT DECHLORINATION TEMPERATURE	AI	43-CP-01	4	9	1	140ACI04000	
_.		CASADE AERATOR pH	AI	43-CP-01	4	9	2	140ACI04000	
_.		SPARE	AI	43-CP-01	4	9	3	140ACI04000	
_.		SPARE	AI	43-CP-01	4	9	4	140ACI04000	
_.		SPARE	AI	43-CP-01	4	9	5	140ACI04000	
_.		SPARE	AI	43-CP-01	4	9	6	140ACI04000	
_.		SPARE	AI	43-CP-01	4	9	7	140ACI04000	
_.		SPARE	AI	43-CP-01	4	9	8	140ACI04000	
_.		SPARE	AI	43-CP-01	4	9	9	140ACI04000	
_.		SPARE	AI	43-CP-01	4	9	10	140ACI04000	
_.		SPARE	AI	43-CP-01	4	9	11	140ACI04000	
_.		SPARE	AI	43-CP-01	4	9	12	140ACI04000	
_.		SPARE	AI	43-CP-01	4	9	13	140ACI04000	
_.		SPARE	AI	43-CP-01	4	9	14	140ACI04000	
_.		SPARE	AI	43-CP-01	4	9	15	140ACI04000	
_.									
_.		RAS PUMP #1 SPEED COMMAND	AO	43-CP-01	4	10	0	140ACO13000	
_.		RAS PUMP #2 SPEED COMMAND	AO	43-CP-02	4	10	1	140ACO13000	
_.		RAS PUMP #3 SPEED COMMAND	AO	43-CP-03	4	10	2	140ACO13000	
_.		SECONDARY SCUM PUMP #1 SPEED COMMAND	AO	43-CP-04	4	10	3	140ACO13000	
_.		SECONDARY SCUM PUMP #2 SPEED COMMAND	AO	43-CP-05	4	10	4	140ACO13000	
_.		FILTER FEED PUMP #1 SPEED COMMAND	AO	43-CP-06	4	10	5	140ACO13000	
_.		FILTER FEED PUMP #2 SPEED COMMAND	AO	43-CP-07	4	10	6	140ACO13000	
_.		FILTER FEED PUMP #3 SPEED COMMAND	AO	43-CP-08	4	10	7	140ACO13000	
_.									
_.		FILTER FEED PUMP #4 SPEED COMMAND	AO	43-CP-01	4	11	0	140ACO13000	
_.		FILTER FEED PUMP #5 SPEED COMMAND	AO	43-CP-02	4	11	1	140ACO13000	
_.		70-C-01-FE SAMPLER PACES OFF OF INFLUENT FLOW FROM FIT-C5	AO	43-CP-03	4	11	2	140ACO13000	
_.		SODIUM HYPOCHLORITE PUMP #1 SPEED COMMAND	AO	43-CP-04	4	11	3	140ACO13000	
_.		SODIUM HYPOCHLORITE PUMP #1 STROKE COMMAND	AO	43-CP-05	4	11	4	140ACO13000	
_.		SODIUM HYPOCHLORITE PUMP #2 SPEED COMMAND	AO	43-CP-06	4	11	5	140ACO13000	
_.		SODIUM HYPOCHLORITE PUMP #2 STROKE COMMAND	AO	43-CP-07	4	11	6	140ACO13000	
_.		SODIUM HYPOCHLORITE PUMP #3 SPEED COMMAND	AO	43-CP-08	4	11	7	140ACO13000	
_.									
_.		SODIUM HYPOCHLORITE PUMP #3 STROKE COMMAND	AO	43-CP-01	4	12	0	140ACO13000	
_.		SODIUM BISULFITE PUMP #1 SPEED COMMAND	AO	43-CP-02	4	12	1	140ACO13000	
_.		SODIUM BISULFITE PUMP #1 STROKE COMMAND	AO	43-CP-03	4	12	2	140ACO13000	
_.		SODIUM BISULFITE PUMP #2 SPEED COMMAND	AO	43-CP-04	4	12	3	140ACO13000	
_.		SODIUM BISULFITE PUMP #2 STROKE COMMAND	AO	43-CP-05	4	12	4	140ACO13000	
_.		ALUM FEED PUMP #1 SPEED COMMAND	AO	43-CP-06	4	12	5	140ACO13000	
_.		ALUM FEED PUMP #1 STROKE COMMAND	AO	43-CP-07	4	12	6	140ACO13000	
_.		ALUM FEED PUMP #2 SPEED COMMAND	AO	43-CP-08	4	12	7	140ACO13000	
_.									
_.		ALUM FEED PUMP #2 STROKE COMMAND	AO	43-CP-01	4	13	0	140ACO13000	
_.		POLYMER MIX FEED PUMP #1 SPEED COMMAND	AO	43-CP-02	4	13	1	140ACO13000	
_.		POLYMER MIX FEED PUMP #2 SPEED COMMAND	AO	43-CP-03	4	13	2	140ACO13000	
_.		REFRIGERATED SAMPLER PACES OFF OF INFLUENT FLOW FROM FIT-C5	AO	43-CP-04	4	13	3	140ACO13000	
_.		SODIUM HYPOCHLORITE PUMP #6 SPEED COMMAND	AO	43-CP-05	4	13	4	140ACO13000	
_.		SODIUM HYPOCHLORITE PUMP #6 STROKE COMMAND	AO	43-CP-06	4	13	5	140ACO13000	
_.		SODIUM HYPOCHLORITE PUMP #7 SPEED COMMAND	AO	43-CP-07	4	13	6	140ACO13000	
_.		SODIUM HYPOCHLORITE PUMP #7 STROKE COMMAND	AO	43-CP-08	4	13	7	140ACO13000	
_.									
_.		SPARE	AO	43-CP-01	4	14	0	140ACO13000	
_.		SPARE	AO	43-CP-02	4	14	1	140ACO13000	

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EXISTING IO LIST

43-CP-01

TAG NAME	ALARM/STATUS RANGE	DESCRIPTIONS	I/O TYPE	PANEL/RTU LOCATION	RACK	SLOT	CHANNEL	MODULE #	REMARKS
_.		SPARE	AO	43-CP-03	4	14	2	140ACO13000	
_.		SPARE	AO	43-CP-04	4	14	3	140ACO13000	
_.		SPARE	AO	43-CP-05	4	14	4	140ACO13000	
_.		SPARE	AO	43-CP-06	4	14	5	140ACO13000	
_.		SPARE	AO	43-CP-07	4	14	6	140ACO13000	
_.		SPARE	AO	43-CP-08	4	14	7	140ACO13000	
_.									
_.									
_.									
_.									
		TOTAL I/O COUNT - AI:	**48**						
		DI:	**224**						
		DO:	**112**						
		AO:	**40**						

13400 APPENDIX B
EXISTING IO LIST

50-CP-01

TAG NAME	ALARM/STATUS RANGE	DESCRIPTIONS	I/O TYPE	PANEL/RTU LOCATION	RACK	SLOT	CHANNEL	MODULE #	REMARKS
_.		FILTER INFLUENT FLOW METER FIT-J10	AI	50-CP-01	3	3	0	140ACI04000	
_.		SPARE	AI	50-CP-01	3	3	1	140ACI04000	
_.		BACKWASH WATER FLOW FIT-J14	AI	50-CP-01	3	3	2	140ACI04000	
_.		SPARE	AI	50-CP-01	3	3	3	140ACI04000	
_.		WASH WATER FLOW FIT-J20	AI	50-CP-01	3	3	4	140ACI04000	
_.		SPARE	AI	50-CP-01	3	3	5	140ACI04000	
_.		CLEARWELL WATER LEVEL LIT-J15	AI	50-CP-01	3	3	6	140ACI04000	
_.		SPARE	AI	50-CP-01	3	3	7	140ACI04000	
_.		MUDWELL WATER LEVEL LIT-J22	AI	50-CP-01	3	3	8	140ACI04000	
_.		SPARE	AI	50-CP-01	3	3	9	140ACI04000	
_.		BACKWASH WATER VALVE 50-V-13-BW POSITION FEEDBACK ZI-J14	AI	50-CP-01	3	3	10	140ACI04000	
_.		SPARE	AI	50-CP-01	3	3	11	140ACI04000	
_.		SPARE	AI	50-CP-01	3	3	12	140ACI04000	
_.		SPARE	AI	50-CP-01	3	3	13	140ACI04000	
_.		SPARE	AI	50-CP-01	3	3	14	140ACI04000	
_.		SPARE	AI	50-CP-01	3	3	15	140ACI04000	
_.									
_.		BACKWASH WATER FLOW VALVE 50-V-13-BW	AO	50-CP-01	3	4	0	140ACO13000	
_.		SPARE	AO	50-CP-01	3	4	1	140ACO13000	
_.		SPARE	AO	50-CP-01	3	4	2	140ACO13000	
_.		SPARE	AO	50-CP-01	3	4	3	140ACO13000	
_.		SPARE	AO	50-CP-01	3	4	4	140ACO13000	
_.		SPARE	AO	50-CP-01	3	4	5	140ACO13000	
_.		SPARE	AO	50-CP-01	3	4	6	140ACO13000	
_.		SPARE	AO	50-CP-01	3	4	7	140ACO13000	
_.									
_.		FILTER #1 HS-J1-1 REMOTE INPUT INFLUENT VALVE 50-V-02-SE	DI	50-CP-01	3	6	0	140DAI55300	
_.		FILTER #1 ZSH-J1-1 INFLUENT VALVE OPEN	DI	50-CP-01	3	6	1	140DAI55300	
_.		FILTER #1 ZSH-J1-1 INFLUENT VALVE CLOSE	DI	50-CP-01	3	6	2	140DAI55300	
_.		FILTER #1 HS-J1-5 REMOTE INPUT EFFLUENT VALVE 50-V-02-FEF	DI	50-CP-01	3	6	3	140DAI55300	
_.		FILTER #1 ZSH-J1-5 EFFLUENT VALVE OPEN	DI	50-CP-01	3	6	4	140DAI55300	
_.		FILTER #1 ZSL-J1-5 EFFLUENT VALVE CLOSE	DI	50-CP-01	3	6	5	140DAI55300	
_.		FILTER #1 HS-J1-3 REMOTE INPUT BACKWASH AIR VALVE 50-V-01-A	DI	50-CP-01	3	6	6	140DAI55300	
_.		FILTER #1 ZSH-J1-3 BACKWASH AIR VALVE OPEN	DI	50-CP-01	3	6	7	140DAI55300	
_.		FILTER #1 ZSH-J1-3 BACKWASH AIR VALVE CLOSE	DI	50-CP-01	3	6	8	140DAI55300	
_.		FILTER #1 HS-J1-4 REMOTE INPUT CLEAN BW WATER VALVE 50-V-01-BW	DI	50-CP-01	3	6	9	140DAI55300	
_.		FILTER #1 ZSH-J1-4 CLEAN BW WATER VALVE OPEN	DI	50-CP-01	3	6	10	140DAI55300	
_.		FILTER #1 ZSH-J1-4 CLEAN BW WATER VALVE CLOSE	DI	50-CP-01	3	6	11	140DAI55300	
_.		FILTER #1 HS-J1-2 REMOTE INPUT DIRTY BW WATER VALVE 50-V-02-WW	DI	50-CP-01	3	6	12	140DAI55300	
_.		FITLER #1 ZSH-J1-2 DIRTY BW WATER VALVE OPEN	DI	50-CP-01	3	6	13	140DAI55300	
_.		FITLER #1 ZSL-J1-2 DIRTY BW WATER VALVE CLOSE	DI	50-CP-01	3	6	14	140DAI55300	
_.		SPARE	DI	50-CP-01	3	6	15	140DAI55300	
_.		FILTER #2 HS-J2-1 REMOTE INPUT INFLUENT VALVE 50-V-04-SE	DI	50-CP-01	3	6	16	140DAI55300	
_.		FILTER #2 HS-J2-1 INFLUENT VALVE OPEN	DI	50-CP-01	3	6	17	140DAI55300	
_.		FILTER #2 HS-J2-1 INFLUENT VALVE CLOSE	DI	50-CP-01	3	6	18	140DAI55300	
_.		FILTER #2 HS-J2-5 REMOTE INPUT EFFLUENT VALVE 50-V-04-FEF	DI	50-CP-01	3	6	19	140DAI55300	
_.		FILTER #2 ZSH-J2-5 EFFLUENT VALVE OPEN	DI	50-CP-01	3	6	20	140DAI55300	
_.		FILTER #2 ZSH-J2-5 EFFLUENT VALVE CLOSE	DI	50-CP-01	3	6	21	140DAI55300	
_.		FILTER #2 HS-J2-5 REMOTE INPUT BACKWASH AIR VALVE 50-V-02-A	DI	50-CP-01	3	6	22	140DAI55300	
_.		FILTER #2 ZSH-J2-3 BACKWASH AIR VALVE OPEN	DI	50-CP-01	3	6	23	140DAI55300	
_.		FILTER #2 ZSL-J2-3 BACKWASH AIR VALVE CLOSE	DI	50-CP-01	3	6	24	140DAI55300	
_.		FILTER #2 HS-J2-4 REMOTE INPUT CLEAN BW WATER VALVE 50-V-02-BW	DI	50-CP-01	3	6	25	140DAI55300	
_.		FILTER #2 ZSL-J2-4 CLEAN BW WATER VALVE OPEN	DI	50-CP-01	3	6	26	140DAI55300	
_.		FILTER #2 ZSL-J2-4 CLEAN BW WATER VALVE CLOSE	DI	50-CP-01	3	6	27	140DAI55300	
_.		FILTER #2 HS-J2-2 REMOTE INPUT DIRTY BW WATER VALVE 50-V-04-WW	DI	50-CP-01	3	6	28	140DAI55300	
_.		FILTER #2 ZSH-JW-2 DIRTY BW WATER VALVE OPEN	DI	50-CP-01	3	6	29	140DAI55300	
_.		FILTER #2 ZSH-JW-2 DIRTY BW WATER VALVE CLOSE	DI	50-CP-01	3	6	30	140DAI55300	
_.		SPARE	DI	50-CP-01	3	6	31	140DAI55300	
_.									
_.		FILTER #3 HS-J3-1 REMOTE INPUT INFLUENT VALVE 50-V-06-SE	DI	50-CP-01	3	7	0	140DAI55300	
_.		FILTER #3 ZSL-J3-1 INFLUENT VALVE OPEN	DI	50-CP-01	3	7	1	140DAI55300	
_.		FILTER #3 ZSL-J3-1 INFLUENT VALVE CLOSE	DI	50-CP-01	3	7	2	140DAI55300	
_.		FILTER #3 HS-J3-5 REMOTE INPUT EFFULENT VALVE 50-V-06-FEF	DI	50-CP-01	3	7	3	140DAI55300	

13400 APPENDIX B
EXISTING IO LIST

50-CP-01

TAG NAME	ALARM/STATUS RANGE	DESCRIPTIONS	I/O TYPE	PANEL/RTU LOCATION	RACK	SLOT	CHANNEL	MODULE #	REMARKS
_.		FITLER #3 ZSH-J3-5 EFFLUENT VALVE OPEN	DI	50-CP-01	3	7	4	140DAI55300	
_.		FITLER #3 ZSL-J3-5 EFFLUENT VALVE CLOSE	DI	50-CP-01	3	7	5	140DAI55300	
_.		FILTER #3 HS-J3-3 REMOTE INPUT BACKWASH AIR VALVE 50-V-03-A	DI	50-CP-01	3	7	6	140DAI55300	
_.		FILTER #3 ZSH-J3-3 BACKWASH AIR VALVE OPEN	DI	50-CP-01	3	7	7	140DAI55300	
_.		FILTER #3 ZSH-J3-3 BACKWASH AIR VALVE CLOSE	DI	50-CP-01	3	7	8	140DAI55300	
_.		FILTER #3 HS-J3-4 REMOTE INPUT CLEAN BW WATER VALVE 50-V-03-BW	DI	50-CP-01	3	7	9	140DAI55300	
_.		FILTER #3 ZSH-J3-4 CLEAN BW WATER VALVE OPEN	DI	50-CP-01	3	7	10	140DAI55300	
_.		FILTER #3 ZSL-J3-4 CLEAN BW WATER VALVE CLOSE	DI	50-CP-01	3	7	11	140DAI55300	
_.		FILTER #3 HS-J3-2 REMOTE INPUT DIRTY BW WATER VALVE 50-V-06-WW	DI	50-CP-01	3	7	12	140DAI55300	
_.		FILTER #3 ZSH-J3-2 DIRTY BW WATER VALVE OPEN	DI	50-CP-01	3	7	13	140DAI55300	
_.		FILTER #3 ZSH-J3-2 DIRTY BW WATER VALVE CLOSE	DI	50-CP-01	3	7	14	140DAI55300	
_.		SPARE	DI	50-CP-01	3	7	15	140DAI55300	
_.		FILTER #4 HS-J4-1 REMOTE INPUT INFLUENT VALVE 50-V-05-SE	DI	50-CP-01	3	7	16	140DAI55300	
_.		FILTER #4 ZSH-J4-1 INFLUENT VALVE OPEN	DI	50-CP-01	3	7	17	140DAI55300	
_.		FILTER #4 ZSL-J4-1 INFLUENT VALVE CLOSE	DI	50-CP-01	3	7	18	140DAI55300	
_.		FILTER #4 HS-J4-5 REMOTE INPUT EFFLUENT VALVE 50-V-08-FEF	DI	50-CP-01	3	7	19	140DAI55300	
_.		FILTER #4 ZSH-J4-5 EFFLUENT VALVE OPEN	DI	50-CP-01	3	7	20	140DAI55300	
_.		FILTER #4 ZSL-J4-5 EFFLUENT VALVE CLOSE	DI	50-CP-01	3	7	21	140DAI55300	
_.		FILTER #4 HS-J4-3 REMOTE INPUT BACKWASH AIR VALVE 50-V-04-A	DI	50-CP-01	3	7	22	140DAI55300	
_.		FILTER #4 ZSH-J4-3 BACKWASH AIR VALVE OPEN	DI	50-CP-01	3	7	23	140DAI55300	
_.		FILTER #4 ZSL-J4-3 BACKWASH AIR VALVE CLOSE	DI	50-CP-01	3	7	24	140DAI55300	
_.		FILTER #4 HS-J4-4 REMOTE INPUT CLEAN BW WATER VALVE 50-V-04-BW	DI	50-CP-01	3	7	25	140DAI55300	
_.		FILTER #4 ZSH-J4-4 CLEAN BW WATER VALVE OPEN	DI	50-CP-01	3	7	26	140DAI55300	
_.		FILTER #4 ZSL-J4-4 CLEAN BW WATER VALVE CLOSE	DI	50-CP-01	3	7	27	140DAI55300	
_.		FILTER #4 HS-J4-2 REMOTE INPUT DIRTY BW WATER VALVE 50-V-08-WW	DI	50-CP-01	3	7	28	140DAI55300	
_.		FILTER #4 ZSH-J4-2 DIRTY BW WATER VALVE OPEN	DI	50-CP-01	3	7	29	140DAI55300	
_.		FILTER #4 ZSL-J4-2 DIRTY BW WATER VALVE CLOSE	DI	50-CP-01	3	7	30	140DAI55300	
_.		SPARE	DI	50-CP-01	3	7	31	140DAI55300	
_.									
_.		FILTER #1 MANUAL BACKWASH PANEL 50-CS-01 REMOTE	DI	50-CP-01	3	8	0	140DAI55300	
_.		FILTER #1 MANUAL BACKWASH PANEL 50-CS-01 BACKWASH	DI	50-CP-01	3	8	1	140DAI55300	
_.		FILTER #3 MANUAL BACKWASH PANEL 50-CS-01 REMOTE	DI	50-CP-01	3	8	2	140DAI55300	
_.		FILTER #3 MANUAL BACKWASH PANEL 50-CS-01 BACKWASH	DI	50-CP-01	3	8	3	140DAI55300	
_.		FILTER #2 MANUAL BACKWASH PANEL 50-CS-02 REMOTE	DI	50-CP-01	3	8	4	140DAI55300	
_.		FILTER #2 MANUAL BACKWASH PANEL 50-CS-02 BACKWASH	DI	50-CP-01	3	8	5	140DAI55300	
_.		FILTER #4 MANUAL BACKWASH PANEL 50-CS-02 REMOTE	DI	50-CP-01	3	8	6	140DAI55300	
_.		FILTER #4 MANUAL BACKWASH PANEL 50-CS-02 BACKWASH	DI	50-CP-01	3	8	7	140DAI55300	
_.		BACKWASH AIR BLOWER #1 42-B-01-A PRESSURE SWITCH HIGH PSH-J16-1	DI	50-CP-01	3	8	8	140DAI55300	
_.		BACKWASH AIR BLOWER #1 42-B-01-A VIBRATION ALARM HIGH VS-J16-1	DI	50-CP-01	3	8	9	140DAI55300	
_.		BACKWASH AIR BLOWER #1 42-B-01-A TEMPERATION ALARM HIGH TSH-J16-1	DI	50-CP-01	3	8	10	140DAI55300	
_.		BACKWASH AIR BLOWER #1 42-B-01-A REMOTE	DI	50-CP-01	3	8	11	140DAI55300	
_.		BACKWASH AIR BLOWER #1 42-B-01-A RUNNING	DI	50-CP-01	3	8	12	140DAI55300	
_.		BACKWASH AIR BLOWER #1 42-B-01-A FAIL	DI	50-CP-01	3	8	13	140DAI55300	
_.		BACKWASH AIR BLOWER #1 42-B-01-A HIGH BEARING TEMPERATURE	DI	50-CP-01	3	8	14	140DAI55300	
_.		SPARE	DI	50-CP-01	3	8	15	140DAI55300	
_.		BACKWASH AIR BLOWER #2 42-B-02-A PRESSURE SWITCH HIGH PSH-J16-2	DI	50-CP-01	3	8	16	140DAI55300	
_.		BACKWASH AIR BLOWER #2 42-B-02-A VIBRATION ALARM HIGH VS-J16-2	DI	50-CP-01	3	8	17	140DAI55300	
_.		BACKWASH AIR BLOWER #2 42-B-02-A TEMPERATION ALARM HIGH TSH-J16-2	DI	50-CP-01	3	8	18	140DAI55300	
_.		BACKWASH AIR BLOWER #2 42-B-02-A REMOTE	DI	50-CP-01	3	8	19	140DAI55300	
_.		BACKWASH AIR BLOWER #2 42-B-02-A RUNNING	DI	50-CP-01	3	8	20	140DAI55300	
_.		BACKWASH AIR BLOWER #2 42-B-02-A FAIL	DI	50-CP-01	3	8	21	140DAI55300	
_.		BACKWASH AIR BLOWER #2 42-B-02-A HIGH BEARING TEMPERATURE	DI	50-CP-01	3	8	22	140DAI55300	
_.		SPARE	DI	50-CP-01	3	8	23	140DAI55300	
_.		BACKWASH WATER PUMP 50-P-01-BW PRESSURE SWITCH HIGH	DI	50-CP-01	3	8	24	140DAI55300	
_.		BACKWASH WATER PUMP 50-P-01-BW FAIL	DI	50-CP-01	3	8	25	140DAI55300	
_.		BACKWASH WATER PUMP 50-P-01-BW REMOTE	DI	50-CP-01	3	8	26	140DAI55300	
_.		BACKWASH WATER PUMP 50-P-01-BW RUNNING	DI	50-CP-01	3	8	27	140DAI55300	
_.		BACKWASH WATER PUMP 50-P-02-BW PRESSURE SWITCH HIGH	DI	50-CP-01	3	8	28	140DAI55300	
_.		BACKWASH WATER PUMP 50-P-02-BW FAIL	DI	50-CP-01	3	8	29	140DAI55300	
_.		BACKWASH WATER PUMP 50-P-02-BW REMOTE	DI	50-CP-01	3	8	30	140DAI55300	

13400 APPENDIX B
EXISTING IO LIST

50-CP-01

TAG NAME	ALARM/STATUS RANGE	DESCRIPTIONS	I/O TYPE	PANEL/RTU LOCATION	RACK	SLOT	CHANNEL	MODULE #	REMARKS
_.		BACKWASH WATER PUMP 50-P-02-BW RUNNING	DI	50-CP-01	3	8	31	140DAI55300	
_.									
_.		BACKWASH WATER PUMPS 50-P-01-BW & 50-P-02-BW LOW LEVEL	DI	50-CP-01	3	9	0	140DAI55300	
_.		SPARE	DI	50-CP-01	3	9	1	140DAI55300	
_.		SPARE	DI	50-CP-01	3	9	2	140DAI55300	
_.		SPARE	DI	50-CP-01	3	9	3	140DAI55300	
_.		WASHWATER PUMP 50-P-01-WW PRESSURE SWITCH HIGH	DI	50-CP-01	3	9	4	140DAI55300	
_.		WASHWATER PUMP 50-P-01-WW REMOTE	DI	50-CP-01	3	9	5	140DAI55300	
_.		WASHWATER PUMP 50-P-01-WW RUNNING	DI	50-CP-01	3	9	6	140DAI55300	
_.		WASHWATER PUMP 50-P-01-WW FAIL	DI	50-CP-01	3	9	7	140DAI55300	
_.		SPARE	DI	50-CP-01	3	9	8	140DAI55300	
_.		SPARE	DI	50-CP-01	3	9	9	140DAI55300	
_.		SPARE	DI	50-CP-01	3	9	10	140DAI55300	
_.		SPARE	DI	50-CP-01	3	9	11	140DAI55300	
_.		WASHWATER PUMP 50-P-02-WW PRESSURE SWITCH HIGH	DI	50-CP-01	3	9	12	140DAI55300	
_.		WASHWATER PUMP 50-P-02-WW REMOTE	DI	50-CP-01	3	9	13	140DAI55300	
_.		WASHWATER PUMP 50-P-02-WW RUNNING	DI	50-CP-01	3	9	14	140DAI55300	
_.		WASHWATER PUMP 50-P-02-WW FAIL	DI	50-CP-01	3	9	15	140DAI55300	
_.		MUDWELL TANK HIGH LEVEL	DI	50-CP-01	3	9	16	140DAI55300	
_.		MUDWELL TANK LOW LEVEL	DI	50-CP-01	3	9	17	140DAI55300	
_.		SPARE	DI	50-CP-01	3	9	18	140DAI55300	
_.		BACKWASH AIR FLOW LOW	DI	50-CP-01	3	9	19	140DAI55300	
_.		SPARE	DI	50-CP-01	3	9	20	140DAI55300	
_.		UPS TROUBLE ALARM	DI	50-CP-01	3	9	21	140DAI55300	
_.		SPARE	DI	50-CP-01	3	9	22	140DAI55300	
_.		PANEL-D VOLTAGE LOSS ALARM	DI	50-CP-01	3	9	23	140DAI55300	
_.		SPARE	DI	50-CP-01	3	9	24	140DAI55300	
_.		SPARE	DI	50-CP-01	3	9	25	140DAI55300	
_.		SPARE	DI	50-CP-01	3	9	26	140DAI55300	
_.		SPARE	DI	50-CP-01	3	9	27	140DAI55300	
_.		SPARE	DI	50-CP-01	3	9	28	140DAI55300	
_.		SPARE	DI	50-CP-01	3	9	29	140DAI55300	
_.		SPARE	DI	50-CP-01	3	9	30	140DAI55300	
_.		SPARE	DI	50-CP-01	3	9	31	140DAI55300	
_.									
_.		FILTER #1 INFULENT VALVE ACTUATOR 50-V-02-SE CLOSE	DO	50-CP-01	3	10	0	140DRA84000	
_.		FILTER #1 INFULENT VALVE ACTUATOR 50-V-02-SE OPEN	DO	50-CP-01	3	10	1	140DRA84000	
_.		FILTER #1 INFULENT VALVE ACTUATOR 50-V-02-SE STOP	DO	50-CP-01	3	10	2	140DRA84000	
_.		SPARE	DO	50-CP-01	3	10	3	140DRA84000	
_.		FILTER #1 EFFULENT VALVE ACTUATOR 50-V-02-FEF CLOSE	DO	50-CP-01	3	10	4	140DRA84000	
_.		FILTER #1 EFFULENT VALVE ACTUATOR 50-V-02-FEF OPEN	DO	50-CP-01	3	10	5	140DRA84000	
_.		FILTER #1 EFFULENT VALVE ACTUATOR 50-V-02-FEF STOP	DO	50-CP-01	3	10	6	140DRA84000	
_.		SPARE	DO	50-CP-01	3	10	7	140DRA84000	
_.		FILTER #1 BACKWASH WATER VALVE ACTUATOR 50-V-01-BW CLOSE	DO	50-CP-01	3	10	8	140DRA84000	
_.		FILTER #1 BACKWASH WATER VALVE ACTUATOR 50-V-01-BW OPEN	DO	50-CP-01	3	10	9	140DRA84000	
_.		FILTER #1 BACKWASH WATER VALVE ACTUATOR 50-V-01-BW STOP	DO	50-CP-01	3	10	10	140DRA84000	
_.		SPARE	DO	50-CP-01	3	10	11	140DRA84000	
_.		FILTER #1 BACKWASH AIR VALVE ACTUATOR 50-V-01-A CLOSE	DO	50-CP-01	3	10	12	140DRA84000	
_.		FILTER #1 BACKWASH AIR VALVE ACTUATOR 50-V-01-A OPEN	DO	50-CP-01	3	10	13	140DRA84000	
_.		FILTER #1 BACKWASH AIR VALVE ACTUATOR 50-V-01-A STOP	DO	50-CP-01	3	10	14	140DRA84000	
_.		SPARE	DO	50-CP-01	3	10	15	140DRA84000	
_.									
_.		FILTER #1 DIRTY BACKWASH VALVE ACTUATOR 50-V-02-WW CLOSE	DO	50-CP-01	3	11	0	140DRA84000	
_.		FILTER #1 DIRTY BACKWASH VALVE ACTUATOR 50-V-02-WW OPEN	DO	50-CP-01	3	11	1	140DRA84000	
_.		FILTER #1 DIRTY BACKWASH VALVE ACTUATOR 50-V-02-WW STOP	DO	50-CP-01	3	11	2	140DRA84000	
_.		SPARE	DO	50-CP-01	3	11	3	140DRA84000	
_.		FILTER #2 INFULENT VALVE ACTUATOR 50-V-04-SE CLOSE	DO	50-CP-01	3	11	4	140DRA84000	
_.		FILTER #2 INFULENT VALVE ACTUATOR 50-V-04-SE OPEN	DO	50-CP-01	3	11	5	140DRA84000	
_.		FILTER #2 INFULENT VALVE ACTUATOR 50-V-04-SE STOP	DO	50-CP-01	3	11	6	140DRA84000	
_.		SPARE	DO	50-CP-01	3	11	7	140DRA84000	
_.		FILTER #2 EFFULENT VALVE ACTUATOR 50-V-04-FEF CLOSE	DO	50-CP-01	3	11	8	140DRA84000	
_.		FILTER #2 EFFULENT VALVE ACTUATOR 50-V-04-FEF OPEN	DO	50-CP-01	3	11	9	140DRA84000	

13400 APPENDIX B
EXISTING IO LIST

50-CP-01

TAG NAME	ALARM/STATUS RANGE	DESCRIPTIONS	I/O TYPE	PANEL/RTU LOCATION	RACK	SLOT	CHANNEL	MODULE #	REMARKS
_.		FILTER #2 EFFULENT VALVE ACTUATOR 50-V-04-FEF STOP	DO	50-CP-01	3	11	10	140DRA84000	
_.		SPARE	DO	50-CP-01	3	11	11	140DRA84000	
_.		FILTER #2 BACKWASH WATER VALVE ACTUATOR 50-V-02-BW CLOSE	DO	50-CP-01	3	11	12	140DRA84000	
_.		FILTER #2 BACKWASH WATER VALVE ACTUATOR 50-V-02-BW OPEN	DO	50-CP-01	3	11	13	140DRA84000	
_.		FILTER #2 BACKWASH WATER VALVE ACTUATOR 50-V-02-BW STOP	DO	50-CP-01	3	11	14	140DRA84000	
_.		SPARE	DO	50-CP-01	3	11	15	140DRA84000	
_.									
_.		FILTER #2 BACKWASH AIR VALVE ACTUATOR 50-V-02-A CLOSE	DO	50-CP-01	3	12	0	140DRA84000	
_.		FILTER #2 BACKWASH AIR VALVE ACTUATOR 50-V-02-A OPEN	DO	50-CP-01	3	12	1	140DRA84000	
_.		FILTER #2 BACKWASH AIR VALVE ACTUATOR 50-V-02-A STOP	DO	50-CP-01	3	12	2	140DRA84000	
_.		SPARE	DO	50-CP-01	3	12	3	140DRA84000	
_.		FILTER #2 DIRTY BACKWASH VALVE ACTUATOR 50-V-04-WW CLOSE	DO	50-CP-01	3	12	4	140DRA84000	
_.		FILTER #2 DIRTY BACKWASH VALVE ACTUATOR 50-V-04-WW OPEN	DO	50-CP-01	3	12	5	140DRA84000	
_.		FILTER #2 DIRTY BACKWASH VALVE ACTUATOR 50-V-04-WW STOP	DO	50-CP-01	3	12	6	140DRA84000	
_.		SPARE	DO	50-CP-01	3	12	7	140DRA84000	
_.		FILTER #3 INFULENT VALVE ACTUATOR 50-V-06-SE CLOSE	DO	50-CP-01	3	12	8	140DRA84000	
_.		FILTER #3 INFULENT VALVE ACTUATOR 50-V-06-SE OPEN	DO	50-CP-01	3	12	9	140DRA84000	
_.		FILTER #3 INFULENT VALVE ACTUATOR 50-V-06-SE STOP	DO	50-CP-01	3	12	10	140DRA84000	
_.		SPARE	DO	50-CP-01	3	12	11	140DRA84000	
_.		FILTER #3 EFFULENT VALVE ACTUATOR 50-V-06-FEF CLOSE	DO	50-CP-01	3	12	12	140DRA84000	
_.		FILTER #3 EFFULENT VALVE ACTUATOR 50-V-06-FEF OPEN	DO	50-CP-01	3	12	13	140DRA84000	
_.		FILTER #3 EFFULENT VALVE ACTUATOR 50-V-06-FEF STOP	DO	50-CP-01	3	12	14	140DRA84000	
_.		SPARE	DO	50-CP-01	3	12	15	140DRA84000	
_.									
_.		FILTER #3 BACKWASH WATER VALVE ACTUATOR 50-V-03-BW CLOSE	DO	50-CP-01	3	13	0	140DRA84000	
_.		FILTER #3 BACKWASH WATER VALVE ACTUATOR 50-V-03-BW OPEN	DO	50-CP-01	3	13	1	140DRA84000	
_.		FILTER #3 BACKWASH WATER VALVE ACTUATOR 50-V-03-BW STOP	DO	50-CP-01	3	13	2	140DRA84000	
_.		SPARE	DO	50-CP-01	3	13	3	140DRA84000	
_.		FILTER #3 BACKWASH AIR VALVE ACTUATOR 50-V-03-A CLOSE	DO	50-CP-01	3	13	4	140DRA84000	
_.		FILTER #3 BACKWASH AIR VALVE ACTUATOR 50-V-03-A OPEN	DO	50-CP-01	3	13	5	140DRA84000	
_.		FILTER #3 BACKWASH AIR VALVE ACTUATOR 50-V-03-A STOP	DO	50-CP-01	3	13	6	140DRA84000	
_.		SPARE	DO	50-CP-01	3	13	7	140DRA84000	
_.		FILTER #3 DIRTY BACKWASH VALVE ACTUATOR 50-V-06-WW CLOSE	DO	50-CP-01	3	13	8	140DRA84000	
_.		FILTER #3 DIRTY BACKWASH VALVE ACTUATOR 50-V-06-WW OPEN	DO	50-CP-01	3	13	9	140DRA84000	
_.		FILTER #3 DIRTY BACKWASH VALVE ACTUATOR 50-V-06-WW STOP	DO	50-CP-01	3	13	10	140DRA84000	
_.		SPARE	DO	50-CP-01	3	13	11	140DRA84000	
_.		FILTER #4 INFLUENT VALVE ACTUATOR 50-V-08-SE CLOSE	DO	50-CP-01	3	13	12	140DRA84000	
_.		FILTER #4 INFLUENT VALVE ACTUATOR 50-V-08-SE OPEN	DO	50-CP-01	3	13	13	140DRA84000	
_.		FILTER #4 INFLUENT VALVE ACTUATOR 50-V-08-SE STOP	DO	50-CP-01	3	13	14	140DRA84000	
_.		SPARE	DO	50-CP-01	3	13	15	140DRA84000	
_.									
_.		FILTER #4 EFFLUENT VALVE ACTUATOR 50-V-08-FEF CLOSE	DO	50-CP-01	4	3	0	140DRA84000	
_.		FILTER #4 EFFLUENT VALVE ACTUATOR 50-V-08-FEF OPEN	DO	50-CP-01	4	3	1	140DRA84000	
_.		FILTER #4 EFFLUENT VALVE ACTUATOR 50-V-08-FEF STOP	DO	50-CP-01	4	3	2	140DRA84000	
_.		SPARE	DO	50-CP-01	4	3	3	140DRA84000	
_.		FILTER #4 BACKWASH WATER VALVE ACTUATOR 50-V-04-BW CLOSE	DO	50-CP-01	4	3	4	140DRA84000	
_.		FILTER #4 BACKWASH WATER VALVE ACTUATOR 50-V-04-BW OPEN	DO	50-CP-01	4	3	5	140DRA84000	
_.		FILTER #4 BACKWASH WATER VALVE ACTUATOR 50-V-04-BW STOP	DO	50-CP-01	4	3	6	140DRA84000	
_.		SPARE	DO	50-CP-01	4	3	7	140DRA84000	
_.		FILTER #4 BACKWASH AIR VALVE ACTUATOR 50-V-04-A CLOSE	DO	50-CP-01	4	3	8	140DRA84000	
_.		FILTER #4 BACKWASH AIR VALVE ACTUATOR 50-V-04-A OPEN	DO	50-CP-01	4	3	9	140DRA84000	
_.		FILTER #4 BACKWASH AIR VALVE ACTUATOR 50-V-04-A STOP	DO	50-CP-01	4	3	10	140DRA84000	
_.		SPARE	DO	50-CP-01	4	3	11	140DRA84000	
_.		FILTER #4 DIRTY BACKWASH VALVE ACTUATOR 50-V-08-WW CLOSE	DO	50-CP-01	4	3	12	140DRA84000	
_.		FILTER #4 DIRTY BACKWASH VALVE ACTUATOR 50-V-08-WW OPEN	DO	50-CP-01	4	3	13	140DRA84000	
_.		FILTER #4 DIRTY BACKWASH VALVE ACTUATOR 50-V-08-WW STOP	DO	50-CP-01	4	3	14	140DRA84000	
_.		ALARM HORN	DO	50-CP-01	4	3	15	140DRA84000	
_.									
_.		BACKWASH AIR BLOWER #1 42-B-01-A LOADSHED	DO	50-CP-01	4	4	0	140DRA84000	
_.		BACKWASH AIR BLOWER #1 42-B-01-A START/STOP	DO	50-CP-01	4	4	1	140DRA84000	
_.		BACKWASH AIR BLOWER #1 42-B-02-A LOADSHED	DO	50-CP-01	4	4	2	140DRA84000	
_.		BACKWASH AIR BLOWER #1 42-B-02-A START/STOP	DO	50-CP-01	4	4	3	140DRA84000	

13400 APPENDIX B
EXISTING IO LIST

50-CP-01

TAG NAME	ALARM/STATUS RANGE	DESCRIPTIONS	I/O TYPE	PANEL/RTU LOCATION	RACK	SLOT	CHANNEL	MODULE #	REMARKS
_.		BACKWASH WATER PUMPS 50-P-01-BW LOADSHED	DO	50-CP-01	4	4	4	140DRA84000	
_.		BACKWASH WATER PUMPS 50-P-01-BW START/STOP	DO	50-CP-01	4	4	5	140DRA84000	
_.		BACKWASH WATER PUMPS 50-P-02 BW LOADSHED	DO	50-CP-01	4	4	6	140DRA84000	
_.		BACKWASH WATER PUMPS 50-P-02-BW START/STOP	DO	50-CP-01	4	4	7	140DRA84000	
_.		WASHWATER PUMPS 50-P-01-WW LOADSHED	DO	50-CP-01	4	4	8	140DRA84000	
_.		WASHWATER PUMPS 50-P-01-WW START/STOP	DO	50-CP-01	4	4	9	140DRA84000	
_.		WASHWATER PUMPS 50-P-02-WW LOADSHED	DO	50-CP-01	4	4	10	140DRA84000	
_.		WASHWATER PUMPS 50-P-02-WW START/STOP	DO	50-CP-01	4	4	11	140DRA84000	
_.		LOADSHED VALVE DIST. PANEL PANEL 'D'	DO	50-CP-01	4	4	12	140DRA84000	
_.		SPACE	DO	50-CP-01	4	4	13	140DRA84000	
_.		CUSTOMER FILTRATION FAIL ALARM	DO	50-CP-01	4	4	14	140DRA84000	
_.		SPACE	DO	50-CP-01	4	4	15	140DRA84000	
_.		FILTER INFLUENT TURBIDITY	AI	50-CP-01	4	5	0	140ACI04000	
_.		SPARE	AI	50-CP-01	4	5	1	140ACI04000	
_.		FILTER EFFLUENT TURBIDITY	AI	50-CP-01	4	5	2	140ACI04000	
_.		SPARE	AI	50-CP-01	4	5	3	140ACI04000	
_.		FILTER #1 LEVEL	AI	50-CP-01	4	5	4	140ACI04000	
_.		SPARE	AI	50-CP-01	4	5	5	140ACI04000	
_.		FILTER #2 LEVEL	AI	50-CP-01	4	5	6	140ACI04000	
_.		SPARE	AI	50-CP-01	4	5	7	140ACI04000	
_.		FILTER #3 LEVEL	AI	50-CP-01	4	5	8	140ACI04000	
_.		SPARE	AI	50-CP-01	4	5	9	140ACI04000	
_.		FILTER #4 LEVEL	AI	50-CP-01	4	5	10	140ACI04000	
_.		SPARE	AI	50-CP-01	4	5	11	140ACI04000	
_.		SPARE	AI	50-CP-01	4	5	12	140ACI04000	
_.		SPARE	AI	50-CP-01	4	5	13	140ACI04000	
_.		SPARE	AI	50-CP-01	4	5	14	140ACI04000	
_.		SPARE	AI	50-CP-01	4	5	15	140ACI04000	
_.									
		TOTAL I/O COUNT - AI:	**32**						
		DI:	**128**						
		DO:	**96**						
		AO:	**8**						

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SECTION 13420 – CONTROL PANELS AND HARDWARE

PART 1 GENERAL

1.1 SCOPE OF WORK

A. Furnish and install process control panels as shown on the Drawings and specified herein.

B. The Contract Documents are a single integrated document, and as such all Divisions and Sections apply. It is the responsibility of the CONTRACTOR and Subcontractors to review all sections to insure a complete and coordinated project.

C. Related Work

1. Section 13400 – Common Work results Process Instrumentation and Controls

2. Section 13421 – Programmable Logic Controllers and Computer Control Systems

3. Section 13422 – Local Area Network Systems

D. The following new panels and consoles shall be furnished by the Contractor under this Section.

Panel Designation	Minimum Panel Size	Enclosure Rating & Type
Screening/Grit Handling Bldg RIO Control Panel (16-CP-02)	72”H x 36”W x 24”D	NEMA Type 12 Steel Free-Standing Front-Access Only
Blower Bldg PLC Control Panel (27-CP-01)	72”H x 36”W x 24”D	NEMA Type 12 Steel Free-Standing Front-Access Only
MCC-D3 RIO Control Panel (34-CP-01)	N/A	Integrated into MCC-D3 Structure. Refer to Section 16442
WAS Storage RIO Control Panel (51-CP-01)	72”H x 36”W x 24”D	NEMA Type 4X 316 Stainless Steel Free-Standing, 2-Door Front-Access Only Air Conditioning Unit
Biosolids Dryer Bldg PLC Control Panel (52-CP-01)[1]	72”H x 36”W x 24”D	NEMA Type 12 Steel Free-Standing Front-Access Only

Notes:

1. Work is included as part of Schedules C, D and E and shall not be performed if those Schedules are not selected. Refer to Specification Section 01025 – Measurement and Payment for additional detail on Bid Schedules.

E. The following panels and consoles are existing or furnished under other sections of these Specifications. Interface and/or modify panels as required per the Contract Documents for a fully functioning system.

Panel Designation	Panel Supplier
Administration Bldg Control Panel (80-CP-01)[1]	Existing Panel
Biosolids Dryer Bldg Dryer System Master PLC (52-MCP-01) [1]	Dryer System Supplier (Section 11600)
Biosolids Dryer Bldg Dryer System Loadout Local Control Panel (52-LCP-01) [1]	Dryer System Supplier (Section 11600)
Biosolids Dryer Bldg Dryer System Thermal Fluid System Local Control Panel (52-LCP-02) [1]	Dryer System Supplier (Section 11600)
Biosolids Dryer Bldg Dryer System Air Compressor Local Control Panel (52-LCP-03) [1]	Dryer System Supplier (Section 11600)
Biosolids Dryer Bldg Dryer System Paddle Dryer Local Control Panel (52-LCP-04) [1]	Dryer System Supplier (Section 11600)
Blower Bldg Blower System Master PLC (27-MCP-01) [1]	Blower System Supplier (Section 13550)
Blower Bldg Blower #1 Local Control Panel (27-LCP-01)	Blower System Supplier (Section 11502)
Blower Bldg Blower #2 Local Control Panel (27-LCP-02)	Blower System Supplier (Section 11502)
Blower Bldg Blower #3 Local Control Panel (27-LCP-03)	Blower System Supplier (Section 11502)

Panel Designation	Panel Supplier
Blower Bldg Blower #4 Local Control Panel (27-LCP-04)	Blower System Supplier (Section 11502)
Chemical Bldg PLC Control Panel (43-CP-01)	Existing Panel
Filter Bldg PLC Control Panel (50-CP-01)	Existing Panel
Recycled Water Electrical Bldg RIO Control Panel (64-CP-01)	By Others (Not In Contract)
Screening/Grit Handling Bldg PLC Control Panel (16-CP-01)	Existing Panel
Solids Handling Bldg PLC Control Panel (14-CP-01) [1]	Existing Panel
Solids Handling Bldg Local Panel (14-LP-03) [1]	Existing Panel
Solids Handling Bldg Local Panel (14-LP-10) [1]	Conveyor System Supplier (Section 14552)

Notes:

1. Work is included as part of Schedules C, D and E and shall not be performed if those Schedules are not selected. Refer to Specification Section 01025 – Measurement and Payment for additional detail on Bid Schedules.

1.2 SUBMITTALS

A. Submittals shall be made in accordance with Section 13400.

1.3 QUALITY ASSURANCE

A. Refer to Section 13400.

1.4 DELIVERY, STORAGE AND HANDLING

A. Control panels shall be shipped directly to the site from the factory. Before the control panels are shipped, remove all case-mounted instruments from the face of the panels, and repack in their original shipping cartons for shipment to the site with the control panel

B. Throughout this Contract, the Contractor shall provide protection for materials and equipment against loss or damage and from the effects of weather. Prior to installation, store items in indoors in a dry location and follow all manufacturers' storage instructions. Provide heating in storage areas for items subject to corrosion under damp conditions. Provide covers for panels and other elements that may be exposed to dusty construction environments. Specific storage requirements shall be in accordance with the manufacturer's recommendations of the equipment being provided.

1.5 SPARES

A. General:

1. In addition to the items noted below and in the other specification sections, the Contractor shall provide suitable spare parts and expendable items in sufficient quantities to sustain the SCADA system for a period of 1 year after final acceptance. All spare parts shall be delivered to the site before testing begins.

2. The following tabulation of spare parts and maintenance equipment is presented as a minimum of suitable types and quantities to be provided.

a. Fuses: 20 percent spares of each size and type used, but no less than 10 of each size and type.

b. Indicating Light Bulb: 20 percent spares of each size and type used, but no less than 10 of each size and type.

c. 24V Loop DC Power Supplies: 20 percent spares of each size and type used, but no less than three of each size and type.

PART 2 PRODUCTS

2.1 GENERAL

A. The dimensions on the specified and shown on the Drawings are for general reference only. The PCSI shall be responsible for ensuring final enclosure sizing and panel arrangements accommodate all required equipment for a fully integrated and operational system as specified herein and in the Contract Documents.

B. Control panels shall conform to the requirements of the NEC Article 409.

C. Each control panel shall be manufactured and assembled per the requirements of UL 508A. The complete assembly shall bear the UL label as an Industrial Control Panel as defined by UL 508A. If required for UL labeling, provide ground fault protective devices, isolation transformers, fuses and other equipment as necessary to achieve compliance with the UL standard. The Drawings do not detail all UL requirements.

D. The UL label requirements shall apply to all panels except where enclosures contain instruments mounted through the enclosure walls or doors. In this case, panel construction shall meet all requirements of UL labeling as described above, but no UL label is required. This exception applies only if UL Recognized instruments or devices for the intended purpose are not made.

E. Where two or more units of the same class of materials or equipment are required, provide products of a single manufacturer. Component parts of materials or equipment need not be products of the same manufacturer.

F. Standard products: Unless otherwise indicated, provide material and equipment that is the standard product of manufacturers regularly engaged in the production of such materials and equipment. Provide the manufacturer's latest standard design that conforms to the specifications.

G. All panel doors shall have a lock installed in the door handle, or a hasp and staple for padlocking. Locks for all panels provided under this Contract shall be keyed alike.

H. The instruments designated for rear-of-panel mounting shall be arranged within the panel according to respective panel drawings and in a manner to allow for ease of maintenance and adjustment.

I. The panels shall be completely fabricated, instruments installed and wired at the PCSI's facility.

J. All components shall be mounted in a manner that shall permit servicing, adjustment, testing and removal without disconnecting, moving or removing any other component. Components mounted on the inside of panels shall be mounted on removable plates and not directly to the enclosure. Mounting shall be rigid and stable unless shock mounting is required otherwise by the manufacturer to protect equipment from vibration. Components mounting shall be oriented in accordance with the internal components shall be identified with suitable plastic or metal engraved tags attached with drive pins adjacent to (not on) each component identifying the component in accordance with the drawing, specifications, and PCSI's data.

K. All exterior panel mounted equipment shall be installed with suitable gaskets, faceplates, etc. required to maintain the NEMA rating of the panel.

L. Nameplates

1. All panels and panel devices shall be supplied with suitable nameplates which identify the panel and individual devices as required. Each device nameplate shall include up to three lines with the first line containing the device tag number as shown on the drawings, the second line containing a functional description (e.g., Recirculation Pump No. 1), and the third line containing a functional control description (e.g., Start).

2. Unless escutcheon plates are specified or unless otherwise noted on the Drawings, nameplates shall be 3/32 inch thick, black and white, Lamicoid with engraved inscriptions. The letters shall be Black against a White background unless otherwise noted. Edges of the nameplates shall be beveled and smooth. Nameplates with chipped or rough edges will not be acceptable. Nameplates shall be affixed to the panels using 4-40 thread stainless steel button head hex screws or epoxy adhesive to maintain the integrity of the NEMA panel rating.

3. Provide legend plates or 1-in by 3-in engraved nameplates with 1/4-in lettering for identification of door mounted control devices, pilot lights and meters.

4. Refer also to Section 16075.

M. Mounting Elevations

1. ISA Recommended Practice RP60.3 shall be used as a guide in layout and arrangement of panels and panel mounted components. Dimensions shall account for all housekeeping pads that panels will sit on once they are installed.

2. Centerline of indicators and controllers shall be located no lower than 48 inches or higher than 66 inches above the floor on a panel face.

3. Centerline of lights, selector switches and pushbuttons shall be located no lower than 32 inches or higher than 70 inches above the floor on a panel face.

4. Tops of annunciators or monitoring lights shall be located no higher than 86 inches above the floor on a panel face.

5. Installation of panel components shall conform to component manufacturers' guidelines.

2.2 TYPICAL EQUIPMENT

A. Structure and Enclosure

1. Panels shall be of continuous welded-steel construction. Provide steel angle stiffeners as required on the back of the panel face to prevent panel deflection under instrument loading or operation. Internally the panels shall be supplied with a structural steel framework for instrument support purposes and panel bracing. The internal framework shall permit panel lifting without racking or distortion. Provide removable lifting rings designed to facilitate simple, safe rigging, and lifting of the control panels during installation. Plugs shall be provided and shall unobtrusively fill the panel lifting ring holes when substituted for the lifting rings after installation is complete. Plugs shall not compromise the overall NEMA rating of the panel.

2. Each panel shall be provided with full height, fully gasketed access doors where shown. Doors shall be provided with a three-point stainless steel latch (except for NEMA 4X panels) and heavy duty stainless steel locking handle. Rear access doors shall be conveniently arranged and sized such that they extend no further than 24 inches beyond the panel when opened to the 90-degree position. Front and side access doors shall be as shown. Panel access doors shall be provided with full length, continuous, piano type stainless steel hinges with stainless steel pins. Front access doors with mounted instruments or control devices shall be of sufficient width to permit door opening without interference from flush mounted instruments.

3. The panels, including component parts, shall be constructed and assembled in a thoroughly workmanlike manner and shall be free from sharp edges and welding flaws. Wiring shall be free from kinks and sharp bends and shall be routed for easy access to other components for maintenance and inspection purposes.

4. The panel shall be suitable for top or bottom conduit entry as required by the Electrical Drawings. For top mounted conduit entry the panel top shall be provided with nominal one foot square removable access plates which may be drilled to accommodate conduit and cable penetrations. All conduit and cable penetrations shall be provided with ground bushings, hubs, gasketed locknuts, or other accessories as required to maintain the NEMA rating of the panel and electrical rating of the conduit system.

5. All panels in indoor, dry, non-corrosive environments shall be NEMA 12 unless otherwise noted. All panels in outdoor, wet and non-chemically corrosive environments shall be NEMA 4 unless otherwise noted. Panels in chemically corrosive environments shall be NEMA 4X unless otherwise noted. All panels located in a Hazardous location (e.g., Class 1, Division 1) shall be rated NEMA 7.

6. Freestanding vertical panels shall meet the NEMA classification as shown on the drawings or specified herein. The panels shall be constructed of 12 gauge sheet steel, suitably braced internally for structural rigidity and strength. All NEMA 4X rated wall mounted panels shall be constructed of 316 stainless steel, unless FRP is specifically indicated to be provided. Front panels or panels containing instruments shall be not less than 10 gauge stretcher leveled sheet steel, reinforced to prevent warping or distortion.

7. Free standing panels in NEMA 4 and NEMA 4X locations shall be provided with 316 stainless steel floor stands to allow for conduit entry in the bottom of the enclosure. Conduit penetrations shall be rated for the area in which they are installed in order to maintain the NEMA rating of the panel.

8. Each enclosure shall be provided with a print pocket 12" wide x 12" high x 2" deep located on the interior of the door.

9. Where shown on the Drawings, floor mounted enclosures shall have a nominal 12” x 12” folding shelf. Folding shelf shall have steel locking support arms. Panel arrangement shall allow full opening of the folding shelf without obstructions or relocating components, panel wiring, or equipment.

10. All wall mounted panels shall meet the NEMA classification as shown on the drawings or specified herein. The panels shall be constructed of not less than USS 14 gauge steel, suitably braced internally for structural rigidity and strength. All NEMA 4X rated wall mounted panels shall be constructed of 316 stainless steel, unless FRP is specifically shown or specified. FRP panels shall be used in chlorine areas. All FRP panels located in direct sunlight shall be provided with a protective coating and sun shield to prevent discoloration and cracking.

11. Finish Requirements

    a. All sections shall be descaled, degreased, filled, ground and finished. The enclosure when fabricated of steel shall be finished with two rust resistant phosphate prime coats and two coats of enamel, polyurethane, or lacquer finish which shall be applied by either the hot air spray or conventional cold spray methods. Brushed anodized aluminum, stainless steel, and FRP panels will not require a paint finish.

b. The panels shall have edges ground smooth and shall be sandblasted and then cleaned with a solvent. Surface voids shall be filled and ground smooth.

c. Immediately after cleaning, one coat of a rust-inhibiting primer shall be applied inside and outside, followed by an exterior intermediate and top coat of a two-component type epoxy enamel. A final sanding shall be applied to the intermediate exterior coat before top coating.

d. Apply a minimum of two (2) coats of flat white lacquer on the panel interior after priming.

e. Unless otherwise noted, the finish exterior colors shall be ANSI 49 gray with a textured finish. Stainless steel enclosures are not required to be painted.

2.3 ENVIRONMENTAL CONTROL

A. All enclosures shall be provided with a thermostatically controlled strip heater to reduce condensation and maintain the minimum internal panel temperature.

B. All panels shall be provided with louvers, sun shields, heat sinks, forced air ventilation, or air conditioning units as required to prevent temperature buildup inside of panel. The internal temperature of all panels shall be regulated to a range of 45 Deg F to 104 Deg F under all conditions. Under no circumstances shall the panel cooling or heating equipment compromise the NEMA rating of the panel.

C. PCSI shall submit heat dissipation calculations for every control panel.

D. Except for panels mounted with their backs directly adjacent to a wall, louvers shall be in the rear of the panels, top and bottom, and shall be stamped sheet metal construction.

E. For panels mounted with their backs directly adjacent to a wall, louvers shall be on the sides.

F. Forced air ventilation fans, where used, shall provide a positive internal pressure within the panel and shall be provided with washable or replaceable filters. Fan motors shall operate on 120-volt, 60-Hz power.

G. For panels with internal heat that cannot be adequately dissipated with natural convection and heat sinks, or forced air ventilation, an air conditioner shall be provided.

H. Provide custom fabricated sun shields for all outdoor panels in accordance with the following requirements:

1. Sun shields shall be fabricated from minimum 12 gauge Type 316 Stainless Steel. Units shall be designed, fabricated, installed and supported to fully cover and shade the top, sides and back of the enclosure, and to partially shade the front panel of the enclosure, from direct exposure to sunlight from sunrise to sunset.

2. Depending on overall size, sun shields may be fabricated in single or multiple segments for attachment to the enclosure support framing or to separate free standing framing around the enclosure.

3. Sun shields shall not be attached directly to the enclosure by drilling holes through, or welding studs to, the enclosure surfaces, and shall be designed and mounted to provide a minimum 3 inch air gap all around the enclosure for air circulation and heat dissipation.

4. The top section of all sun shields shall be sloped at a minimum angle of 5 degrees from horizontal. For wall mounted enclosures, the top section shall slope downward away from the wall and towards the front of the enclosure. For free standing, floor mounted and frame mounted enclosures the top section shall slope downward towards the back side of the enclosure.

5. The front edge of the top section of all sun shields shall incorporate a narrow and more steeply sloped drip shield segment which sheds water away from the front of the enclosure and prevents it from dripping and/or running directly onto the front panel of the enclosure.

6. All seam welds used in sun shield fabrication shall be continuous and shall be ground smooth. All exposed corners, edges and projections shall be smooth rounded or chamfered to prevent injury.

2.4 CORROSION CONTROL

A. Panels shall be protected from internal corrosion by the use of corrosion-inhibiting vapor capsules as manufactured by Northern Technologies International Corporation, Model Zerust VC; Hoffman Model A-HCI; or approved equal.

2.5 CONTROL PANEL – INTERNAL CONSTRUCTION

A. Internal Electrical Wiring

1. All interconnecting wiring shall be stranded, type MTW, and shall have 600 volt insulation and be rated for not less than 90 degrees Celsius. Wiring for systems operating at voltages in excess of 120 VAC shall be segregated from other panel wiring either in a separate section of a multi-section panel or behind a removable Plexiglas or similar dielectric barrier. Panel layout shall be developed such that technicians shall have complete access to 120 VAC and lower voltage wiring systems without direct exposure to higher voltages.

2. Power distribution wiring on the line side of fuses or breakers shall be 12 AWG minimum. Control wiring on the secondary side of fuses shall be 14 AWG minimum. Electronic analog circuits shall utilize 16 AWG shielded, twisted pair, cable insulated for not less than 600 volts.

3. Power and low voltage DC wiring systems shall be routed in separate wireways. Crossing of different system wires shall be at right angles. Different system wires routed parallel to each other shall be separated by at least 6-inches. Different wiring systems shall terminate on separate terminal blocks. Wiring troughs shall not be filled to more than 60 percent visible fill.

B. Terminations

1. All wiring shall terminate onto single tier terminal blocks, where each terminal is uniquely and sequentially numbered. Direct wiring between field equipment and panel components, or between panel components, is not acceptable. A maximum of two wires shall be installed in a single terminal point on both the internal and field wiring side of the terminal blocks.

2. Multi-level terminal blocks or strips are not acceptable.

3. Terminal blocks shall be arranged in vertical rows and separated into groups (power, AC control, DC signal). Each group of terminal blocks shall have a minimum of 25 percent spares. Provide unique color coded terminal blocks for different voltages, functions, and signal types.

4. Terminal blocks shall be the compression type, fused, unfused, or switched as shown on the Drawings or specified elsewhere in Division 13.

5. Discrete inputs and outputs (DI and DO) shall have two terminals per point with adjacent terminal assignments. All active and spare points shall be wired to terminal blocks.

6. Analog inputs (AI) shall have five terminals per shielded pair connection with adjacent terminal assignments for each point. Terminals shall include a fused terminal block for powering loop powered devices, two terminals for connection of the analog input signal, and one terminal for DC common to be used for loop powered devices. The fifth terminal is for shielded ground connection for cable pairs. Note that additional terminals may be required for completion of a current loop of analog devices. Ground the shielded signal cable at the PLC cabinet. Provide additional fusing where required as specified under Division 13. Provide additional terminals to accommodate loops powering multiple devices such as isolators or indicators. All active and spare points shall be wired similarly with circuit wiring completed to the field terminal blocks including all protective devices, circuit tagging, and bundling specified.

7. Analog outputs (AO) shall have three terminals per shielded pair connection with adjacent terminal assignments for each point. The third terminal is for shielded ground connection for cable pairs. Note that additional terminals may be required for completion of a current loop of analog devices. Ground the shielded signal cable at the PLC cabinet. Provide additional fusing where required as specified under Division 13. Provide additional terminals to accommodate loops powering multiple devices such as isolators or indicators. All active and spare points shall be wired similarly with circuit wiring completed to the field terminal blocks including all protective devices, circuit tagging, and bundling specified.

8. Wire and tube markers shall be the sleeve type with heat impressed letters and numbers.

9. Only one side of a terminal block row shall be used for internal wiring. The field wiring side of the terminal shall not be within 6-inches of the side panel or adjacent terminal or within 8-inches of the bottom of free standing panels, or within 3-inches of stanchion mounted panels, or 3-inches of adjacent wireway.

10. Terminal blocks shall be tubular clamp type rated 600 VAC/VDC minimum and as specified on drawings. If fuse terminal blocks are specified, they shall be with built-in puller and with fuse size as required. Provide 20% spare terminals for every terminal strip, space permitting. Terminals shall be clearly and permanently labeled with embossed numbers as shown on drawings. Provide raised and angled terminals for incoming field device circuits.

11. Terminal block jumpers: Where indicated on the drawings, terminal block jumpers shall be pre-made specifically designed for the application. Jumpers designed to screw in on top of terminal blocks are preferred.

12. Provide all necessary accessories, partition plates, separating plates, end cover, group markers, etc., as required for proper installation of the terminal blocks.

13. Standard control terminal blocks:

    a. Standard control terminal blocks shall be designed to accept No. 22 to No. 12 AWG wires. Terminal blocks shall be gray or beige colored and rated for 30 amperes, 600 VAC/VDC.

    b. Terminal blocks for analog 4-20mA circuits shall be knife-style isolation (circuit disconnect) type. Provide with IEC disconnect fuse with blown indicator.

    c. Acceptable products: Allen-Bradley part numbers are listed; approved equals are acceptable:

        1) Single Circuit Terminal Block: Allen-Bradley 1492-J4.

        2) Two Circuit Terminal Block (For digital I/O field wiring interface applications only): Allen-Bradley 1492-JD4.

        3) Knife-Style Isolating Terminal Block (For analog 4-20mA or 1-5VDC applications only): Allen-Bradley 1492-JKD4.

        4) Fused Terminal Block: Fused terminal blocks shall be designed to accept No. 22 to No. 12 AWG copper wires. It shall be black colored with red LED for fuse indication and rated for 12A, 57VAC/VDC. Fuse size shall be ¼” x 1 ¼”; Allen-Bradley 1492-H5 or approved equal.

        5) Grounding Terminal Block: Allen-Bradley 1492-JG3.

        6) Side Jumpers: Allen-Bradley 1492-N49.

        7) Plug-In Center Jumpers: Allen-Bradley 1492-CJLJ6 (where XX is the number of poles).

        8) End Anchor: Allen Bradley 1492-ERL35.

        9) End Barrier (Single Circuit Terminal Blocks): Allen-Bradley 1492-EBJ3.

        10) End Barrier (Two Circuit Terminal Blocks): Allen-Bradley 1492-EBJD4.

11) End Barrier (Grounding Terminal Blocks): Allen-Bradley 1492-EBJ3.

12) Marking Systems (1492-J4 and 1492-JG3 terminal blocks):Allen-Bradley 1492-M6X12 (snap-in marker cards) or Allen-Bradley 1492-M5X12.

13) Marking Systems (1492-JD4 terminal blocks): Allen-Bradley 1492-M6X5 (snap-in marker cards)

14) Marking Systems (1492-JKD4 terminal blocks): Allen-Bradley 1492-MS8X12 (snap-in marker cards)

15) Marking Systems (1492-H5 fuse blocks): Allen-Bradley 1492-MS8X12 (snap-in marker cards).

14. Heavy Duty Terminal Block shall be designed to accept wires up to No. 10 AWG. Terminal blocks shall be gray colored and rated for 30 amperes, 600 VAC/VDC. Acceptable products: Allen Bradley 1492 W6, Phoenix Contact Universal “UK” Terminal Blocks, or approved equal.

C. All wiring to circuits where foreign voltages are present (that is live circuits independent of the panel's normal circuit breaker protection) shall be clearly identified using yellow wiring insulation. The existence of foreign circuits shall also be indicated with yellow Phenolic nameplates with on the panel exterior with red engraved lettering reading “CAUTION FOREIGN VOLTAGES PRESENT”.

D. All wiring shall be clearly tagged on both ends of the wire and color coded. All tag numbers and color coding shall correspond to the panel wiring diagrams and electrical schematic drawings prepared by the PCSI. All power wiring, control wiring, grounding and DC wiring shall utilize different color insulation for each wiring system used. The color coding scheme shall be:

1. Incoming 120 VAC Hot – Black

2. 120 VAC Hot wiring downstream of panel circuit breaker – Red

3. 120 VAC Hot wiring derived from a UPS system – Red with Black stripe

4. 240, 208 or 480 VAC wiring – as specified in Division 16

5. 120 VAC neutral – White

6. Ground – Green

7. DC power or control wiring – Blue

8. DC analog signal wiring – Black (–), White or Red (+)

9. Foreign voltage – Yellow

E. Power supplies and backup power:

1. Provide circuits for all internal panel power distribution including 120VAC utility power, 120VAC UPS power, and 24VDC instrument power, as shown on the drawings and specified herein.

2. PCSI shall be responsible for the final power supply design approach, equipment selection, equipment ratings, wiring, protective devices, and all other elements of the control panel power supplies as specified and shown on the Drawings.

3. Provide power failure under-voltage relays for monitoring 24 VDC power supply and 120V AC power supply at each control panel provided under this Contract.

F. Provide surge protectors on all incoming power supply lines at each panel per the requirements of Section 13400. Provide control, signal and communication line surge suppression in accordance with Section 13400.

G. Each field instrument furnished under Division 13 and shown on the Drawings as deriving input power from the control panel(s) shall have a separate power distribution circuit with a circuit breaker or fuse and blown fuse indication.

H. All internal components in the control panels shall be fed from 24 VDC power supplies as required to power field instruments, panel devices, PLC's, switches, etc. 24 VDC power supplies shall be as specified. Internal panel components and control circuits shall have a separate power distribution circuits with a circuit breaker or fuse and blown fuse indication.

I. Wiring trough for supporting internal wiring shall be plastic type with snap on covers. The side walls shall be open top type to permit wire changing without disconnecting. Trough shall be supported to the subpanel by stainless steel screws. Trough shall not be bonded to the panel with glue or adhesives. Provide one-inch minimum wire bending radius to prevent wires from being kinked or stressed at the wiring duct junctions. Wiring duct sizes shall not exceed 50%.

J. Each panel shall have a single tube, fluorescent light fixture, 20 Watt in size, mounted internally to the ceiling of the panel. Light fixture shall be switched and shall be complete with the lamp. Light fixture shall be fed from 120V in the control panel.

K. Each panel shall have a specification grade duplex convenience receptacle with ground fault interrupter, mounted internally within a stamped steel device box with appropriate cover. Convenience receptacle shall be powered from the panel 120V utility circuit.

L. Each panel shall be provided with an isolated copper grounding bus for all signal and shield ground connections. Shield grounding shall be in accordance with the instrumentation manufacturer's recommendations.

M. Each panel shall be provided with a separate copper power grounding bus (safety) in accordance with the requirements of the National Electrical Code.

N. Additional electrical components including transformers, motor starters, switches, circuit breakers, etc. shall be in compliance with the requirements of Division 16.

O. Relays not provided under Division 16 and required for properly completing the control function specified in Division 13, Division 16, or shown on the Drawings shall be provided under this Section.

2.6 COMPONENTS

A. Control panels that contain motor controls, starters, drives, or circuits greater than 300VAC shall include a panel mounted molded case main circuit breaker for branch circuit overcurrent protection and disconnecting means of source power to the control panel. The panel mounted main circuit breaker shall include a flange type or rotary mechanism with through door handle for operation of the main breaker. The operating mechanism shall include a mechanical interlock that will allow the panel door to open only when the handle is in the OFF position. A bypass feature shall be included such that the panel door can be opened when the handle is on the ON position.

B. Supplementary circuit breakers may be used for isolation and protection of control cable, coils, contacts and circuit elements within the control panel and tapped from the load side of branch circuit protective devices. Use of this type of breaker is in addition to the branch circuit overcurrent breaker.

C. A mechanical disconnect mechanism, with bypass, shall be installed on each motor circuit protector, capable of being locked in the "OFF" position to provide a means of disconnecting power to the motor.

D. Auxiliary contacts shall be provided for remote run indication and indication of each status and alarm condition. Additional controls shall be provided as specified herein and as required by the detailed mechanical equipment requirements and as shown on the Drawings.

E. Control panels that contain only low voltage control circuits shall include a din rail mounted UL-489 Listed main circuit breaker for branch circuit overcurrent protection and disconnecting means of source power to the control panel.

F. All components shall be provided with finger safe terminals. Where finger safe terminals are not available for a specific component, the panel shall include insulated barriers to prevent accidental contact with energized components.

G. All operating control devices and instruments shall be securely mounted on the exterior door for panels installed in interior location, inner dead-front doors for panels installed in outdoor locations, or as shown on the Drawings. All controls shall be clearly labeled to indicate function and shall be in accordance with the electrical area classification indicated on the Electrical Drawings.

H. Indicator lamps shall be heavy duty, industrial type, high-visibility LED, full voltage type pilot lights. Units shall have screw on plastic lenses and shall have factory engraved legend plates as required. Lens color shall be green for OFF, red for ON and amber for BYPASS or ALARM. Indicator lamps shall be by Allen-Bradley; Eaton Corporation or approved equal.

I. Mode selector switches (e.g. HAND-OFF-AUTO, LOCAL-OFF-REMOTE, PUMP SELECTOR, LEAD-LAG, etc.) shall be heavy-duty, industrial type with contacts rated for 120 VAC at 10 Amps continuous. Units shall have standard size, black field, and legend plates with white markings, as indicated. Operators shall be black knob type. Units shall have the number of positions and contact arrangements, as required. Provide spring return style switches where shown on the Contract Documents. Units shall be single-hole mounting, accommodating panel thicknesses from 1/16-in minimum to 1/4-in maximum. Selector switches shall be by Allen-Bradley; Eaton Corporation or approved equal.

J. Push-button, shall be heavy-duty, industrial type with momentary or maintained contacts as required, rated for 120 VAC at 10 Amps continuous. Units shall have standard size, black field, and legend plates with white markings, as indicated. Button color shall be red for EMERGENCY STOP or START and green for STOP. Contact arrangement shall be as required. Local emergency stop pushbuttons shall be red with mushroom head type, non-spring return (pull to reset type). Provide all emergency stop push-buttons with plastic finger guards to minimize risk of accidental pushbutton activation. Push-buttons shall be by Allen-Bradley; Eaton Corporation or approved equal.

K. Process indicators

1. Digital Process Indicators: Digital process indicators shall be 7 segment red LED displays with minimum 4-1/2 digits. Minimum digit height shall be 0.5-inches. Units shall accept current or voltage input and be housed in plastic casing suitable for front panel display of the process variable meeting NEMA 12 or better enclosure rating. Indicator shall be suitable for direct 4-20mA current loop operation, powered from 24VDC power supply. Configuration shall be via integral device keypad. Provide Red Lion Controls, Model PAXLA; Crompton; or approved equal.

L. Interposing Relays

1. Interposing relays shall be provided where external signal voltages or contact ratings are not suitable for direct interface to control panel components, or as shown on the Drawings. Interposing relays shall be DIN rail mounted, single pole type, with 6A, 120VAC rated contacts, and coils rated as required for the application. Interposing relays shall be Finder 38 Series, or approved equal.

M. Control Panel Circuit Breakers

1. Panel mounted main or branch circuit overcurrent protection breaker – Breaker shall be 120VAC, thermal magnetic type and be manufactured and tested per UL 489 standards. Short circuit rating shall be a minimum of 10kAIC. Breaker shall be suitable for panel mounting and include a through the door handle mechanism. Breaker shall be manufactured by Eaton, Square D, GE or Equal.

2. DIN rail mounted main or branch circuit overcurrent protection breaker – Breaker shall be industrial, thermal magnetic type, 120VAC rated and be manufactured and tested per UL 489 standards. Short circuit rating shall be a minimum of 10kAIC. Breaker shall be manufactured by Eaton, Allen Bradley, Weidmuller or Equal,

3. Supplementary breakers – Supplementary breakers shall be DIN rail mounted high density, energy limiting type rated for the circuit voltage in which it is installed. Breaker shall be used per the exceptions of the NEC and as tested per UL 1077. Breakers shall be manufactured by Eaton, Allen Bradley, GE or approved equal.

N. Instrument and Panel Power Supply (120VAC to 24VDC):

1. Single-phase DIN-rail mounted, switched-mode power supply with 120VAC input, 24VDC nominal output. Output shall be adjustable and regulated over the range 22.5 to 28.5 VDC. Power supplies shall be sized for their connected load plus 50% spare capacity.

2. The power supply shall have an efficiency greater than 87% with maximum peak-to-peak voltage ripple of less than 100mV.

3. Where shown on the drawings, provide DC power supplies in a fully redundant configuration with a diode bridge redundancy module. The redundancy module shall be of the same manufacturer and series as the power supplies provided, and sized for the full capacity of each power supply. The redundancy module shall include a DC “OK” LED and an alarm contact output.

4. Power supply shall have the following status signals:

   a. DC “OK” LED which remains lit during normal power supply operation, flashes when the output voltage has dropped by more than 10%, and is off when no input voltage is present.

   b. An isolated DC “OK” relay contact rated 1A at 30V.

5. Acceptable products: Sola SDN Series, Allen Bradley, Weidmuller, or approved equal.

O. Ground Bar

1. Ground bars shall be UL listed and have suitable number and size of terminals necessary for terminating stranded copper ground wires.

2. Acceptable products: Square D Ground Bar Kits, or approved equal.

PART 3 EXECUTION

3.1 INSTALLATION

A. Install equipment specified above as shown on the drawings. Follow all manufacturers’ instructions when installing panel devices and accessories.

B. Mount circuit breakers below 79-inches above finished floor.

C. Mount common switching power supplies on horizontal or vertical DIN rail per the equipment manufacturer’s recommendation so that no de-rating is required.

D. Mount terminal blocks on vertical wireways on the bottom of the panel, unless otherwise noted by the equipment manufacturer. Field and internal terminations shall be on opposite sides of the terminal block. Arrange terminals for segregation of field and internal wires, and segregation of 120VAC wires and signal wires.

E. Mount PLC I/O modules near the terminal block area. Arrange the modules with 120VAC I/O and signal I/O on opposite sides.

F. Unless noted otherwise by the manufacturer's layout recommendations, layout the backpanel in the following arrangement, from top to bottom, with wireway in between each:

1. Network and communications equipment.
2. 24VDC power supply and DC distribution.
3. 120VAC power supply and AC distribution.
4. Relays and timers.
5. PLC racks.
6. I/O racks.
7. Terminal blocks.

3.2 FIELD QUALITY CONTROL

A. All control panel testing and documentation shall be in accordance with Sections 13400.

END OF SECTION

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SECTION 13421 – PROGRAMMABLE LOGIC CONTROLLERS AND COMPUTER CONTROL SYSTEMS

PART 1 GENERAL

1.1 SCOPE OF WORK

A. Provide programmable logic controllers (PLCs), Human Machine Interface (HMI) workstations, and other SCADA ancillary equipment where shown on the Drawings and as specified herein.

B. The Contract Documents are a single integrated document, and as such all Divisions and Sections apply. It is the responsibility of the Contractor and Subcontractors to review all sections to insure a complete and coordinated project.

C. The City's SCADA system is based on the Schneider Electric/Modicon M580 and M340 hardware and UnityPRO software platform. The City has developed standardized blocks of PLC code, referred to as "Defined Function Blocks" (DFBs), and HMI graphics to provide SCADA uniformity at all facilities, minimize system development effort, and simplify operator training. The collection of DFBs and their associated graphics have been developed using Schneider Electric UnityPRO PLC programming software and Inductive Automation Ignition HMI application package. These DFBs shall be used as the basis for the new system programming at the WWTP without exception. The City control system standards information shall be provided to the PCSI at the first Control System Coordination Workshop.

D. Perform final integration and implementation of the new control elements in to the existing system. Provide installation, testing, and commissioning of the final integrated system that shall include both new PCSI developed and modified existing control logic elements. Final integration of newly developed and modified control logic elements into the existing WWTP SCADA system shall be performed by the PCSI without exception.

E. Human Machine Interface hardware, portions of the PLC hardware, and elements of the HMI and PLC software control logic are existing. Modify the existing PLC and HMI hardware, control logic, and graphic systems to incorporate the new and revised process control elements provided under this Contract. Provide new and revised PLC programming and HMI configuration including development of control programs, database configuration, graphic screens, communication links, historical archiving, and other programming tasks as specified herein. Coordinate all programs with City Controls Engineers to ensure that the HMI development, PLC programs, communications links, databases and other SCADA elements match the existing City approach and standards.

F. Existing City PLC control logic files, HMI application including screens and operator interfaces, historian databases, and other City standards shall be provided to the Contractor after Notice To Proceed. Existing programing scheme shall be used as templates for matching logic development, program structure, and HMI look and feel to the greatest extent possible.

G. Provide SCADA system configuration, integration, and programming for all SCADA components for a fully functioning and complete system. Modify existing servers and HMIs, modify existing PLCs, and provide new PLCs complete with hardware, software and programming for a fully configured control system at the City of Brentwood's WWTP.

H. Furnish and install communication and networking equipment including fiber optic interfaces, network switches, firewalls, and other equipment as shown on the Drawings and specified herein. Provide network and communication equipment as specified in Section 13422.

1.2 RELATED WORK

A. Section 13400 – Common Work Results for Process Instrumentation and Controls (including Appendices)

B. Section 13420 – Control Panels and Hardware

C. Section 13422 – Local Area Network Systems

D. Section 13482 – Process Control Descriptions

E. Section 13490 – Commissioning of Process Control Systems

1.3 SUBMITTALS

A. Refer to Section 13400

1.4 REFERENCES

A. Refer to Section 13400.

1.5 MAINTENANCE

A. As a minimum, provide the following:

1. One spare PLC Central Processor Module.

2. 10% spare I/O card modules of each type provided under this Contract, minimum of one.

3. One spare PLC dedicated rack mounted communication card of each type provided under this Contract.

4. One spare separately mounted ancillary communication module, isolator, or other auxiliary component.

5. One spare power supply of each type provided under this Contract.

6. Ten percent (10%) (minimum of 2) of each type of miscellaneous components, switches, lights, cable connectors, and other field replaceable system components provided under this Contract.

B. All spare parts shall be carefully packed in cartons, labeled with indelible markings, and shall be adequately treated for a long period of storage. Complete ordering information including manufacturer's part number, part ordering information including manufacturer, part number, part name, and equipment name and number(s) for which the part is to be used shall be supplied with the required spare parts. The spare parts shall be delivered and stored in a location directed by City.

PART 2 PRODUCTS

2.1 SCADA EQUIPMENT – GENERAL

A. Equipment shall be designed to operate on a 60 Hertz alternating current power source at a nominal 120 volts, plus or minus 10 percent, except where specifically noted. Regulators and power supplies required for compliance with the above shall be provided. Where equipment requires voltage regulation, constant voltage transformers shall be supplied.

B. Materials and equipment used shall be UL approved wherever such approved equipment and materials are available.

C. The system shall be designed and constructed to withstand the demands of real time process management and control.

D. All equipment, cabinets and devices furnished hereunder shall be heavy-duty type, designed for continuous industrial service. The system shall contain products of a single manufacturer, insofar as possible, and shall consist of equipment models that are currently in production. All equipment provided shall be of modular construction and shall be capable of field expansion through the installation of plug-in circuit cards or additional cabinets.

E. All equipment furnished shall be designed and constructed so that in the event of power interruption, or temperatures outside the operational range, the systems specified hereunder shall go through an orderly shutdown with no loss of memory, and resume normal operation without manually resetting when power is restored.

F. All software required to achieve the functionality described in the Specifications shall be provided. All software provided under this Contract shall be licensed to the City of Brentwood. Coordinate with the City for licensing details and points of contact.

G. Only software platforms and releases approved by the City for use shall be installed.

2.2 PROGRAMMABLE LOGIC CONTROLLERS (PLCS) GENERAL

A. The PLCs shall communicate between the operator workstation and field mounted transducers, switches, controllers, and process actuators. Communications protocol shall be completely transparent to process operators at the HMI. The PLC shall be an intelligent microprocessor based device that can collect data and process control functions. Communications with the operator workstation shall utilize the Ethernet 802.3 compliant data highway as shown in the Drawings. The PLC shall reside directly on the Ethernet data highway and communications shall be via a PLC chassis mounted Ethernet communications module as manufactured by the PLC manufacturer. Ancillary or third party Ethernet equipment required to connect the PLC to the Ethernet data highway shall not be acceptable.

B. All components of the PLC system shall be of commonly recognized industry standards and regularly sold for industrial installations. All components shall be assembled by the PLC manufacturer into standard structurally sound housings. All connecting cables, switches, and other operator-controlled devices shall be constructed to withstand, without damage, all normal use and handling. The PCSI as specified in Section 13400 shall be responsible for installation of the equipment in control panel enclosures as specified in Section 13420.

C. The PLC system shall be of modular design with a plug-in processing unit, input/output cards, or assemblies. All components shall be marketed and supported by the one manufacturer. All necessary auxiliary cables, terminating components, connectors, and modules shall be included for a fully functioning PLC network system.

D. Electrical supply voltage to the PLC shall be 24VDC derived from the incoming UPS 120VAC supply. PLC system power supplies shall be fused for overload protection. Each PLC (including all I/O) shall be powered from the power supply and conditioning system as shown on the Drawings.

E. The PLC shall be capable of and configured for stand-alone operation in the event of failure of the communication links.

F. All products shall be designed, manufactured, and tested in accordance with recognized industrial standards, UL, CSA, and/or FM approval.

G. The PLC subsystems shall be approved for and adhere to the following agency and environmental specifications:

1. Vibration: 3.5 mm Peak-to-Peak, 5-9 Hz: 1.0G, 9-150 \Hz, or 2G @ 10 … 500Hz. The method of testing is to be based upon IEC 68-2-6standards for vibration. The system is to be operational during and after testing.

2. Shock: 15G, 11 msec or operating rating of 30G for 11ms and storage rating of 50G for 11ms. The method of testing is to be based upon IEC 68-2-27standards for shock. The system is to be operational during and after testing.

3. Temperature: All PLC hardware shall operate at an ambient temperature of 0 to 60 degrees C (32 to 140 degrees F), with an ambient temperature rating for storage of - 40 to + 85 degrees C (- 40 to + 185 degrees F).

4. Relative Humidity: The Programmable Controller hardware shall function continuously in the relative humidity range of 5% to 95% with no condensation.

5. Corrosion Protection: Provide PLC components with conformal coating on all components and modules where available as a standard option from the manufacturer.

6. Noise Immunity: The Programmable Controller system shall be designed and tested to operate in the high electrical noise environment of an industrial plant as governed by the following regulations: IEEE 472, IEC 801, MILSTD 461B, IEC 255-4, NEMA ICS 2-230.40, and ANSI/IEEE C-37.90A-1978

H. Modules are defined herein as devices which plug into a chassis and are keyed to allow installation in only one direction. The design must prohibit upside down insertion of the modules as well as safeguard against the insertion of a module into the wrong slot.

I. In a single chassis system all system and signal power to the CPU and support modules shall be distributed on a single motherboard or backplane. No interconnecting wiring between these modules via plug-terminated jumpers shall be acceptable.

J. All system modules, main and expansion chassis shall be designed to provide for free air flow convection cooling. No internal fans or other means of cooling, except heat sinks, shall be permitted.

K. All major assemblies and sub-assemblies, circuit boards, and devices shall be identified using permanent labels or markings, each of which indicates the manufacturer's catalog number and a product manufacturing date code.

2.3 MAIN PROGRAMMABLE LOGIC CONTROLLERS (PLCS)

A. Provide PLC platforms for performing system wide control functions, network monitoring, hot-standby redundancy failover, and communications to the WWTP's central SCADA facility.

B. Provide a dual slot redundancy ready processor capable of 16MB of base program and data memory, with a 4GB SD memory card for additional data storage.

C. PLCs shall be Schneider Electric Modicon M580 redundant pairs in Hot-Standby configuration, Model No. BMEH584040, no equal to match the City's existing SCADA system hardware.

D. Main PLC configuration software shall be IEC 61131-3 compliant programming software, Schneider Electric UnityPRO, no equal to match the PLC hardware.

E. Major hardware components of the Main PLC platform shall include:

1. Central Processing Unit (CPU)

2. Redundancy and Hot Back-Up Equipment

3. Input/Output Modules

4. Communications Modules

5. Power Supply

F. Central Processing Unit (CPU):

1. General

a. The CPU shall provide system timing and perform scheduling I/O updates, with no user programming required to ensure discrete or analog update. It shall execute user relay ladder logic programs, communicate with intelligent I/O modules, and perform on-line diagnostics. The CPU shall consist of a single module which solves application logic, stores the application

program, stores numerical values related to the application processes and logic, and interfaces to the I/O.

b. The CPU shall sample all the discrete and analog inputs and outputs including internal coils and registers and service special function modules every scan. The CPU shall process the I/O with user program (s) stored in memory, and then control the outputs based on the results of the logic operation.

c. The CPU shall execute the user program by rapidly scanning the program stored in user memory. Both logic and data word functions shall be executed in the order they appear in the user program. As each section or rung of logic is solved, the results shall be available to any of the following logic elements.

d. The CPU shall support an instruction to allow a decrease in scan time by skipping over parts of the program when directed. The CPU shall allow the PLC program to be broken into logic subroutines that execute only when called. The PLC shall allow analog and discrete points to be updated immediately within the scan as the discrete or analog value is called in the configuration program.

e. The CPU shall be a single printed circuit board utilizing surface mount technology. The CPU shall plug directly into the I/O base and require no additional wiring to the base, power supply, or the I/O.

f. Provide program execution and support remote or local programming. The CPU shall provide I/O scanning and peer to peer inter-processor communication to other PLCs in the system and to peripheral support devices.

g. Store programs in either battery backed RAM or non-volatile flash memory. Data registers shall be stored in battery backed RAM.

h. Provide a battery backed integral real-time clock that can be accessed from the control program. The clock shall include registers for the time of day (year, month, day, hour, minute, second, and day of the week). The real-time clock, synchronized with an external device such as a PC or another PLC as specified in Section 13482. Permit changing program and data values while running without interrupting the process.

i. The PLC CPU family shall allow for user program transportability from one CPU model to another.

2. Capacity

a. The CPU shall be capable of supporting up to 16 remote I/O drops.

b. Processor performance shall be rated at least 40,000 instructions per millisecond at a program make up of 100% Boolean instructions, and 30,000 instructions per millisecond at a program make up of 65% Boolean and 35% fixed arithmetic.

3. Diagnostics

a. Read the inputs, perform all system logic, conduct on-line diagnostics, and control the outputs. Diagnostics shall include memory checks, communications monitoring, I/O bus monitoring, watchdog timing, and user program validation.

b. Monitor the health of every module in the local and Remote I/O backplanes. A single bit shall show the active or inactive state of each module. Information shall be accessible from the program, from programming software, or remotely from the HMI.

c. The CPU shall perform on-line diagnostics that monitor the internal operation of the PLC. If a failure is detected, the CPU shall initiate system shutdown and fail-over if a failure occurs. The following at a minimum shall be monitored:

1) Memory Failure

2) Memory battery low

3) CPU over temperature and general fault

4) Communications port failure

5) Scan time over run

6) I/O failure

7) Analog or special function I/O module failure

d. All diagnostic information shall be accessible at the programming terminal which attaches to the CPU. A diagnostic page on the PLC programming terminal shall provide information which identifies the nature of the fault, the absolute memory or I/O address of the fault, and the date and time of occurrence of the fault.

e. PLC diagnostic information shall be accessible to the host communications interfaces. Develop platform specific HMI PLC monitoring screens for presenting PLC diagnostics using the HMI configuration software specified herein to present the specific module failure to the operator.

f. The CPU shall have LED indicators to show status such as PLC GOOD, PROGRAM RUN, and BATTERY GOOD. If any of the above conditions occur, provide an internal PLC diagnostic fail alarm contact output. The CPU within the system shall perform internal diagnostic checking and give visual indication to the user by illuminating a "green" indicator when no fault is detected and a "red" indicator when a fault is detected.

4. Memory

a. The CPU shall contain CMOS RAM program memory or compact flash storage memory. The CMOS RAM or compact flash memory shall have a battery backup system capable of retaining all memory for a minimum of three (3) months under load and shall require no external or special vents. The Compact flash memory shall have the capability to backup RAM contents during power failures. The backup battery shall be capable of being replaced without interruption of memory integrity or PLC process control functions.

b. A visual indication of backup battery status shall be provided. In the event of low battery voltage, a visual indication and a low battery output alarm contact (for remote alarm) actuation shall be provided before battery failure.

c. The program memory shall be sized as required to implement the functions specified plus a minimum of 10 words (16 bit) for each I/O provided as spare, but shall not be less than 48K bytes. The entire program memory shall be available for user program storage. Scratch pad and "housekeeping" programs shall be included in the calculation of the minimum memory size to ensure adequate spare memory is available to the City for future programming requirements.

d. The PLC CPU memory shall consist of the following functional types of memory:

1) Logic program memory

2) Constant data memory

3) Variable data memory

4) Input/Output memory

5) CPU status data memory

6) I/O word memory

7) User memory for compiled programs

e. Memory allocation and combinations of logic and data storage up to the maximum limits shall be software configurable to match application requirements.

G. Communication Ports

1. Provide a minimum of three (3) PLC CPU rack resident communication ports for local programming, operator interface, and remote I/O operations. Provide ports integral to the CPU or additional manufacturer’s standard add-on communication port modules as required to implement the network communication schemes as shown on the Drawings and specified herein.

H. Remote I/O Communications

1. Existing System

a. PLC to I/O communication shall be installed and configured using Modicon M580 Ethernet RIO ring topology. Each PLC rack shall include an M580 RIO Ethernet Scanner Module, Schneider Electric Type BME, no equal to match existing City equipment.

b. The CPU shall be capable of communicating with a minimum of 8 remote Ethernet RIO base locations with Type X80 I/O. The CPU shall automatically sample and update all local and remote I/O modules each scan cycle of the CPU. Each RIO rack shall include an Ethernet drop adapter, Schneider Electric Model BMECRA31210, no equal to match existing City equipment.

c. Ethernet switches that are installed on the Ethernet RIO networks shall be dual ring switches and be specifically designed and pre-configured by the manufacturer for the specific application in which they are installed. Ethernet RIO switches shall be installed as shown on the drawings and as required where distances between Ethernet RIO locations exceed 300 feet. Ethernet RIO switches shall be Schneider Electric ConneXium managed switches, model number TCSESM063F2CS1, no equal, to match the performance requirements specified for the M580 PLC system.

d. Diagnostic and equipment status information shall be available from each RIO similar to that specified for the CPU.

I. Redundancy and Hot Back-Up Equipment

1. Provide two identical main PLCs configured as a redundant pair. Redundant PLCs shall be configured with separate PLC racks, power supplies, and network and I/O communication port so that any single device failure shall not compromise operation of the overall station PLC control. The PLC shall be supplied with all hardware and software recommended by the manufacturer as required for a completely operational redundant system as shown in the Drawings.

2. During normal operation, I/O status shall be updated in both primary and standby CPU's during each scan, but only the primary CPU shall write outputs. Critical data shall be continuously passed from the primary unit to the standby unit over an independent, dedicated high-performance data highway. All local and remote I/O shall maintain their last position until either communications is re-established or the remote I/O watchdog timer expires. Transfer from primary to standby shall occur in a bumpless, hot standby fashion and not disrupt any system processes.

3. Switch over between the primary PLC and the standby PLC shall occur within 50 milliseconds if any of the following conditions occur in the on-line unit:

a. Power failure

b. CPU fault

c. Communications module fault

d. Change in the on-line unit's mode from RUN to PROGRAM

4. System diagnostics and debugging tools shall be provided to assist in trouble shooting all redundancy equipment.

5. Redundancy shall be a standard feature of the PLC platform and accomplished using a minimum amount of application specific or custom user programming. The PCSI shall provide all PLC configuration necessary to implement the redundant system.

J. Input/Output Modules (I/O)

1. I/O count and type for new PLCs shall be determined by the PCSI as required to implement the functions specified, as shown in Appendix 13400-A, and including the requirement for active spares as noted below.

2. I/O count and type for modification of existing PLCs shall be determined by the PCSI as required to implement the functions specified, as shown in Appendix 13400-B, and including the requirement for active spares as noted below.

3. Each I/O drop or I/O location shall include 20 percent (minimum of two) active input points (both DI and AI) and 20 percent (minimum of two) active outputs points (both DO and AO) for future use. The spares shall be the same type of I/O modules supplied for active process control functions. Spare output points that require the use of an external relay shall be supplied with the external relay. In addition to the indicated wired spares, provide additional 20% spare empty rack space (minimum of two slots) for installation of future I/O cards.

4. All installed unused points on all I/O modules shall be wired to terminal blocks and the termination cabinet in the sequential order that they occur on the I/O modules and in the order that the modules occur in the I/O rack. Termination of all spares at the end of the terminal strips or arbitrarily at random positions on the terminal strips shall not be acceptable. Spare analog input points shall each have their respective internal panel circuiting completed including a powered fuse and three terminal blocks reserved for future wiring and powering from panel powered loops. Refer also to Section 13420.

5. I/O module usage shall comply with the following table unless noted otherwise:

I/O Type	Module Type
Analog input	4-20mA (individually isolated, remote power supply)
Analog output	4-20mA (individually isolated, remote power supply)
Discrete input	24VDC (individually isolated)
Discrete output	24 VDC (with interposing relays)

6. Minimum isolation between input/output and logic voltage shall be 1500V RMS per NEMA standards via opto-isolation for AC I/O modules and 500 VDC for DC and Analog I/O modules.

7. Each I/O module shall have field replaceable fuse protection and blown fuse indicators.

8. The 24 VDC power for analog instrument loops shall be provided by the PCSI as a part of the system. The 24 VDC power supply shall be derived from the input power circuit to the PLC. The field side of the 24 VDC power sources(s) shall have individual fusing and provided with a readily visible, labeled blown fuse indicator. Grouped fusing is not acceptable.

9. Each 24 VDC type discrete output, including spare channels, shall be fully wired out to an associated independent interposing relay located in the same control panel. 120 VAC or 24 VDC power for relay outputs shall be provided from the associated equipment control circuit (as applicable) or independently sourced or protected 120 VAC or 24 VDC power source. Interposing relays shall be as specified in Section 13420.

10. Where multiple mechanical components are provided for process redundancy, their field connections to I/O modules shall be arranged such that the failure of a single I/O module will not disable all mechanical components of the redundant system (i.e., inputs for Pump No. 1 on one input card, inputs for Pump No. 2 on another input card).

11. I/O modules shall contain a maximum of 16 points per card.

12. I/O module usage for existing PLC platforms shall comply with the following table unless noted otherwise:

13. I/O module usage for new PLC platforms shall comply with the following table unless noted otherwise:

    a. Analog input 4-20mA, 8 channels (individually isolated, remote power supply) with 16-Bit resolution, X80 I/O model BMXAMI0810, no equal to match existing City equipment.

    b. Analog output 4-20mA, 4 channels (individually isolated, remote power supply) with 16-Bit resolution, X80 I/O model BMXAMO0410, no equal existing City equipment.

    c. Discrete input, 16 channels, 24VDC sinking, X80 I/O model BMXDDI1602, no equal existing City equipment.

    d. Discrete output, 16 channels, 24 VDC sourcing, X80 I/O model BMXDDO1602, no equal existing City equipment.

K. PLC Rack Power Supply

1. The power supplies shall provide sufficient regulation and ripple control to assure that the rack resident devices being operated can operate within their required tolerances. Output over voltage and over current protective devices shall be provided with the power supply to protect devices from damage due to power supply failure and to protect the power supply from damage due to external failure. Transformers shall have primary and secondary fuse protection.

2. Output over voltage and over current protective devices shall be provided.

3. The PLC shall have chassis mounted power supplies to power the chassis backplane, and provide power for the processor and applicable modules. Provide 24 VDC power supply module selected to power the final load requirements necessary for meeting the functional requirements as specified in the Contract Documents. Provide power supply with total wattage ratings suitable for the devices and modules specified plus an additional 50% capacity.

4. Provide power supplies as manufactured by Schneider Electric Modicon, no equal, sized as required for the CPU and I/O module load requirements.

5. Refer to Section 13420 for panel resident field instrument power supplies.

2.4 SECONDARY PROGRAMMABLE LOGIC CONTROLLERS

A. Provide secondary PLC platforms at non-redundant application drops or for packaged controls as shown on the Drawings. Secondary PLCs shall perform specific equipment or sub-system control functions and network communications. The secondary PLCs shall be Schneider Electric Modicon, Model No. M340, BMX P34 2020; no equal to match the City's existing SCADA system hardware.

B. Secondary PLC configuration software shall be IEC 61131-3 compliant programming software, Schneider Electric Unity Pro, no equal to match PLC hardware.

C. Major hardware components of the Secondary PLC platform include:

1. Central Processing Unit (CPU)

2. Input/Output Modules

3. Communications Modules

4. Power Supply and Racks

D. Central Processing Unit (CPU)

1. Provide chassis mounted modular PLC designed for up to 1024 points of I/O with enhanced processing and communication options.

2. Upon power loss, the PLC shall transfer internal RAM memory to flash memory before RAM powers down if the two programs are different. PLCs with a battery backup for memory storage functions are not acceptable.

3. Provide on board status lights to indicate the following at a minimum:

a. RUN lamp that illuminates when the program is executing

b. ERROR lamp that illuminates when a fault occurs in the processor

c. I/O lamp that illuminates upon an I/O failure or configuration fault

d. SER COM lamp that illuminates when activity is present on the serial port

4. Processor shall be capable of being programmed via a USB port with a PC based programming terminal. The processor shall have an embedded web-server supplied with pre-developed and installed system diagnostics screens viewable from any commercial web-browser. The processor shall have an Ethernet port, USB terminal port, and a multi-protocol serial port capable of Modbus communication.

5. The processor shall accept an 8Mb SD memory card. This card shall store at a minimum application files, data files, PDF files, CAD files, Microsoft office files.

6. Provide processors with 4,096 Kb of internal user RAM with 3,584Kb of base program, constant, and symbol memory, 256K data memory for located and unlocated variables, and an 8M SD card for program backup. Processor shall have a USB terminal port, a multi-protocol serial port, and an Ethernet port. Processor Performance shall be rated at least 6,900 instructions per millisecond at a program make up of 65% Boolean and 35% numerical.

7. Programming cable: The PLC shall utilize a USB to Mini B cable for programming, compatible with those designed for downloading digital cameras to USB compatible PCs. Cable shall be available through most traditional retail stores serving the consumer electronics market.

8. Alarming: The PLC shall have a configurable alarming capability. Each alarm point can be configured to display an alphanumeric message in the alarm buffer. The alarm buffer can be displayed via a web page, or on an operator interface screen.

9. Connector cables:

    a. Unterminated connector cables shall be available for interfacing to the discrete and analog cards. These cables shall have one end terminated to HE10 terminal block modules. The other end shall be unterminated to allow custom interface to panel devices. Provide 5 meter length minimum or as required for final PLC panel configuration.

    b. Terminated connector cables shall be available for interfacing to the discrete and analog cards. These cables shall have one end terminated to interface to terminal block, or FCN socket, cards. The other end shall be terminated to interface with HE10 terminal block modules. Provide 5 meter length minimum or as required for final PLC panel configuration.

E. Input/Output Modules

1. The I/O count and type shall be determined by the PCSI as required to implement the functions specified, as shown in Appendix 13400-A and Appendix 13400-B, and including the requirement for active spares as noted below.

2. Each I/O drop or I/O location shall include 20 percent (minimum of two) active input points (both DI and AI) and 20 percent (minimum of two) active outputs points (both DO and AO) for future use. The spares shall be the same type of I/O modules supplied for active process control functions. Spare output points that require the use of an external relay shall be supplied with the external relay. In

addition to the indicated wired spares, provide additional 20% spare empty rack space (minimum of two slots) for installation of future I/O cards.

3. All installed unused points on all I/O modules shall be wired to terminal blocks and the termination cabinet in the sequential order that they occur on the I/O modules and in the order that the modules occur in the I/O rack. Termination of all spares at the end of the terminal strips or arbitrarily at random positions on the terminal strips shall not be acceptable. Spare analog input points shall each have their respective internal panel circuiting completed including a powered fuse and three terminal blocks reserved for future wiring and powering from panel powered loops. Refer also to Section 13420.

4. Analog Inputs: Provide analog input cards with isolated channels. Provide maximum four channel cards, +/- 10V, 4-20mA, Modicon BMXAMI0410H, no equal to match the City's existing SCADA system hardware

5. Analog Outputs: Provide analog output cards with isolated channels. Provide maximum four channel cards, +/- 10V, 4-20mA output card, Modicon BMXDDO1602, no equal to match the City's existing SCADA system hardware

6. Discrete Inputs: Provide discrete input cards with isolated channels. Provide maximum sixteen channel 24 VDC input card, Modicon BMXAMO0410, no equal to match the City's existing SCADA system hardware.

7. Discrete Outputs: Maximum eight channel 24VDC output card. Provide independent interposing relay located in the same control panel. 120 VAC or 24 VDC power for relay outputs shall be provided from the associated control circuit or independently sourced or protected 120 VAC or 24 VDC power source as required by the driven load. Interposing relays shall be as specified in Section 13420. Provide maximum sixteen channel discrete output card, Modicon BMXDDO1602, no equal to match the City's existing SCADA system hardware.

F. Communications Modules

1. Communication Capabilities: The PLC shall directly support 10/100Mb Modbus TCP Ethernet, ASi V2 Master, Modbus, ASCII, CANopen, and Uni-Telway without the need for third party modules.

2. Ethernet capabilities:

   a. 10/100MB Ethernet with connection via RJ45 connectors

   b. A memory card slot for storage of memory

   c. Built-in web server supplied with pre-developed and installed system diagnostics screens viewable from any commercial web-browser, and the capability of adding custom developed screens

   d. Support for bus, star, ring, and tree topographies with CSMA/CD methodology to access the network and prevent collisions

   e. Modbus TCP messaging

f. Use of ARP and RARP protocols to insure IP and MAC address correspondence

g. Ability to be configured as a BootP client or DHCP server

h. Ability to be configured as Faulty Device Replacement (FDR) server. When configured, a replaced FDR compatible device will request the FDR server for parameters. When this request is received, the PLC will transfer the desired IP address and all configuration parameters to the replaced device.

i. Support of SNMP

j. Global Data support for up to 64 station in each group

k. I/O scanning that allows automatic read and write of remote I/O without programming over Modbus TCP protocol.

G. Power Supply and Racks

1. Power Supplies: The PLC shall have chassis mounted power supplies to power the chassis backplane, and provide power for the processor and applicable modules. Provide 24 VDC power supply module selected to power the final load requirements necessary for meeting the functional requirements as specified in the Contract Documents. Provide power supply with total wattage ratings suitable for the devices and modules specified plus an additional 50% capacity.

2. Chassis: The PLC shall have chassis to mount processors, power supplies, and other applicable cards. Provide 12 position configuration chassis. The chassis will be designed to mount individual enclosed cards. The chassis shall not have top, bottom, or side walls. The cards will be secured to the chassis via a screw connection.

2.5 PLC SOFTWARE

A. Provide a PLC configuration and application development software package complete with documentation and disks. The PLC software package shall be utilized for system configuration using the laptop computer specified herein. All software licenses and warranties shall be assigned to the City by the PCSI.

B. Support on-line/off-line program development, annotation, monitoring, debugging, uploading and downloading of programs to the PLCs via the Ethernet data highway.

C. The software package shall be completely menu driven and shall be distributed on standard CD-ROM.

D. Include a software license agreement allowing the City the right to use the software as required for any current or future modification, documentation, or development of the PLC's furnished for this project.

E. The software shall be capable of the following IEC 61131-3 functions:

1. Function Block Diagram

2. Ladder

3. Structured Text

4. Sequential Function Chart

5. Instruction List

F. A derived function block editor shall work with any of the program editors to create custom reusable function blocks. The software shall allow any of the derived function blocks to be modified on-line.

G. Provide a live simulator which will allow the developer to develop and test programs without the necessity of being connected to a PLC.

H. Programming Environment

1. The CPU shall be capable of being programmed by an external IBM compatible server device via either a serial communication port on the CPU, an Ethernet communication module, or a USB communication port on an I/O bus interface. Serial programming shall be possible without the use of a workstation interface board.

2. The programming device shall have access to the application program, the system configuration, all registers, I/O, system fault status, I/O override, and system diagnostic relays.

3. Application programs may be loaded or stored while the CPU is running with minimal impact on the scan time.

4. If contacts or entire rungs are intentionally deleted from an existing logic program, the remaining program shall be automatically repositioned to fill this void. Whenever contacts or entire rungs are intentionally inserted into an existing program, the original program shall automatically be repositioned to accommodate the expanded program.

5. The number of times a normally open (N.O.) and/or normally closed (N.C.) contact of an internal output can be programmed shall be limited only by the memory capacity to store these instructions.

6. The City prefers function block diagram programming to match existing developed programming code, but will accept relay ladder logic. Instruction list, SFC, or structured text programming shall not be used unless fully developed formats, data structures, layouts, and proposed program structures are submitted by the PCSI and specifically approved by the City. All hardware and software necessary to program the CPU in function block diagram and standard ladder shall be supplied.

I. Instruction Set

1. Perform the same functions as a conventional relay logic system, including relays, timers, counters, and high-level instructions (math, compare, memory pointers, etc.)

2. Perform all functions of conventional three-mode proportional-integral-derivative (PID) analog controllers. Each PID loop shall incorporate an anti-windup algorithm on reset.

3. Address software timers and software counters in any combination and quantity up to the limit of available memory. All management of these instructions into memory shall be handled by the CPU. Instructions shall permit programming timers in the "ON" or "OFF" delay modes. Include the capability to interrupt timing without resetting the timers. Counters shall be programmable using up-increment and down-increment.

4. When using modules such as analog where multiple channels are terminated on one module, it shall be possible to transfer the status of all channels to the CPU upon execution of one program instruction. This instruction shall be bi-directional to include data transfer from the CPU to the module or from the module to the CPU.

5. Provide for grouping contiguous 16 bit data words into a file. The system shall address up to 1000 files with up to 1000 words per file. Support file manipulation instructions such as high speed "file copy" and "file fill", "file to file" move, "element to file" move, "file to element" move, and "first in-first out".

6. Provide asynchronous and synchronous 16 bit word shift registers. Provide synchronous bit shift registers.

7. Support a “GO TO” instruction to jump over portions of the user program to a portion marked by a matching label instruction.

8. Dynamically manage all data types to ensure consistent data types are maintained.

9. Support execution of ladder or program subroutines. It shall be possible to program several subroutines and define each subroutine by a unique program file designator. The processor will support nesting of subroutines up to seven levels deep. The program format as displayed on the CRT shall clearly define the main program and all subroutines. It shall be possible to pass selected values (parameters) to a subroutine before its execution. Subroutines shall not be nested more than one layer deep.

10. Provide "HELP" instructions which, when called by the programmer, will display a list of instructions and all data and keystrokes required to enter an instruction into the system memory.

11. Support entry of comments for all programming platforms. For example, support comment entry for ladder logic rungs, memory addresses, function or programs blocks, or within high level code. Programming platform shall allow engineering comments at the time the programming code is entered.

12. Fault recovery support: When a major system fault occurs in the system, the fault recovery routine shall be executed and the system shall determine if the fault has been eliminated. If the fault is eliminated, program execution resumes. If the fault still exists, the system will shut down. A user shall have the option to either resume operation or to shut down upon fault detection.

13. Provide programmable interrupt routines executed regularly over user specified intervals in the range of 1 to 65,535 milliseconds or executed based upon the input condition of one of 16 discrete hardware inputs in the processor chassis.

14. Support indexed and indirect addressing of inputs and outputs, along with all data table words (integer, binary, floating point, timers, and counters) for the software instruction set.

15. Supported trigonometric instructions must include Sine, Cosine, Tangent, Inverse Sine, Inverse Cosine, and Inverse Tangent. These instructions must fully support floating point math.

16. Additional floating point instructions: Log 10, Natural Log, and Exponential.

17. Support complex, combined calculations in a single instruction, such as flow totalizing or equations of the format ((A+((B-C)*D))/E).

18. Supported file function instructions shall include Sort, Average, Square Root, and Standard Deviation.

19. Support for ASCII string manipulation instructions such as search, concatenation, extraction, compare, and to/from integer conversion.

20. Support ladder functions providing ASCII port control such as read, write, handshake line control, buffer examination, etc.

21. It shall be possible to divide user logic into multiple program blocks (structured programming).

J. The PLC programming platform shall be Microsoft Windows-based. The software shall have an extensive on-line Windows-based help screens. Annotation shall be possible from any Microsoft Windows application. Full text import and export of reference data shall also be possible.

K. The software shall include security features including preventing unauthorized personnel from modifying or downloading the program by or to unauthorized devices.

L. PLC programming software shall be Schneider Electric UnityPRO, no equal, to match existing Owner programs. Software is resident on the City's existing HMI servers, fully virtualized using VMWare's Hypervisor Platform. Providing PLC programming software is not required under this Project. However, the PCSI shall use their own licensed version of UnityPRO for the purposes of the PLC programming required for this project. Final program integration into the City's existing server and PLC configuration shall be performed as specified under Section 13400.

2.6 COMMUNICATION NETWORKS

A. Provide PLC communication network as specified under Section 13422.

2.7 HUMAN MACHINE INTERFACE (HMI) WORKSTATIONS – NOT USED

2.8 LAPTOP – NOT USED

2.9 HMI WORKSTATION CONFIGURATION SOFTWARE

A. General:

1. The PCSI shall match the look, feel, and standards of the existing City SCADA system including graphic screens, reports, database configuration, security, communication, and PLC programming to the greatest extent possible. Examples of City addressing approach, screen graphics, and reports will be provided to the PCSI after award of the Contract and further defined during the PCSI Coordination Workshops per Section 13400. The configuration specified herein refers to general features and elements of the graphic, alarming, reporting, and other features of the SCADA system. However, all specific system elements shall conform to the City standards to the greatest extent possible.

2. HMI Software presently in use at the WWTP is Inductive Automation, Ignition platform. Software is resident on the City's existing HMI servers, fully virtualized using VMWare's Hypervisor Platform.

3. All HMI development shall be performed using City SCADA standard HMI application software, Inductive Automation, Ignition software, no equal, to match existing City programs. Providing HMI programming software is not required under this Project. However, the PCSI shall use their own licensed version of Ignition compatible with the City's installed version for development of all HMI applications required for this project. Final HMI program integration into the City's existing HMI application shall be performed as specified under Section 13400.

4. The PCSI shall provide all development software necessary to perform the work specified for HMI development work. All other software that may be necessary for a fully configured and operational system including communication configuration and other software shall be provided under this contract.

5. Perform all scanning of PLC data tables for transferring analog and discrete data to and from the PLC. Scan periods shall be adjustable to ensure that the PC/PLC communications is scanning at the fastest possible time increment, without data degradation. All communications between the PLCs and the operator interface software shall use the Local Area Network (LAN) directly. It is the responsibility of the PCSI to ensure direct Ethernet 802.3 communications between the PLCs and the Windows based operator interface software package provided. Communications between the operator interface and the PLCs through manufacturer's proprietary data highways (serial or otherwise) or utilizing an operating system other than that specified shall not be acceptable.

6. Perform all data conversions to engineering unit and updates of data files and perform all integration signal conditioning, linearization, etc. The package shall compute data from sensor-based and/or manual inputs for mass flows, total pounds from analysis and flow, ratios, percentages, lab results, minimums, maximums, averages, medians, standard deviations, power use, etc., and store for future retrieval and/or report generation.

7. Perform standard and special calculations required for a water treatment or pumping facility including summation, totaling, averaging, geometric mean, percent removal, percent efficiency, volume, concentration, detention times, loadings, etc.

8. Perform alarm monitoring of discrete and analog inputs/outputs. The analog inputs shall also be checked for out of range (via high and low limit checks). Alarms shall be capable of being assigned to one of three severity categories with each category producing a distinct sound via the System speaker.

9. Supervise and control all routines necessary to respond to operator requests for control changes, displays, allowable operator modifications, printouts, and any other required operator requests. Operator actions shall be serviced on an interrupt basis, and shall be interwoven with normal operations.

10. Permit manual data entry through any of the terminals. Manual data shall consist of laboratory or process specific inputs and entering or changing elements such as alarm limits, setpoints, or constants. Confirmation shall be required via the respective display and keyboard prior to actual entry into the process memory. Security and password protection shall prevent unauthorized data entry.

11. Support all required graphic, semi-graphic, and alpha-numeric displays. The software will both format and display screen images of fixed and dynamic data.

12. Support all required logging and reporting. All logs, reports, and print-outs will be free form, that is the headings and format will be programmed and printed at the time of generation. Any calculations required shall be made at the time of printing. Each page of report shall have the name of the plant, type of report, time and date the report was prepared and the page number. All logs and summary reports, with the exception of the alarm and equipment status logs, shall be allowed to be manually initiated and canceled.

13. Provide the capability to manually OPEN/CLOSE, START/STOP or initiating auto sequences of selected plant equipment via the operator's screen, control device, and keyboard.

14. Provide a minimum of four levels of security to prevent unauthorized usage or modification of the system. Configure security to match existing City standards. Security standards shall be provided during PCSI Coordination Workshops as specified in Section 13400.

15. Provide for presentation of current or historical trending values to either the screen or to the laser printer as selected by the operator.

16. Provide for an automatic reset sequence and adjustable time delay for all alarms. All alarmed analog points shall have an adjustable differential/deadband.

17. Support interface for plant equipment maintenance management and scheduling.

18. Create logical expressions for use in system control using higher level language syntax or scripting.

19. Provide real-time SQL database connectivity.

20. System shall be readily expandable to accommodate future growth of up to a 100% increase in Nodes, I/O points, and HMIs.

B. Graphic Displays

1. The graphic display package shall be capable of supporting at least 256 colors. Color selection for all displays shall be configurable by the City. The package shall provide vector-based scalable graphic displays with a minimum pixel resolution of 1024 by 768 or better as required to conform to existing City displays.

2. The graphic display pages shall be able to include information from I/O points originating from various PLCs, for the formation of actual and pseudo graphics. Graphic displays shall have the ability of combining dynamic analog process variables with standard symbols on the same page.

3. Provide quick switches between development and runtime operator displays.

4. Provide a library of common graphic objects and symbols suitable for ready incorporation into operator displays.

5. The graphic display package shall support import of graphics from other drawing packages such as CorelDRAW and AutoCAD. The graphic display package shall support importing graphics from Microsoft Windows clipboard and objects created by other Microsoft Windows applications via OLE 2.0.

6. All graphic pages shall possess the capability of "poke points" to facilitate movement of an arrow in the graphic and allow the operator to choose specific characters or images for launching linked graphic pages via a mouse.

7. Provide menu driven graphic editor with standard geometric symbols such as lines, circles, rectangles, etc. Provide graphic “wizards” and other scripting functions to simplify development.

8. Provide means to show field conditions with text that can alternate (i.e. OPEN/CLOSE, START/STOP, HIGH/LOW) and change color correspondingly. Field devices that are tri-state must be represented in three conditions. Change of conditions of field devices shall cause the corresponding graphic symbol to change or blink per City standards to alert the operator viewing the graphic.

9. Provide user defined menus conforming to City standards to select and view predetermined summaries and graphics with simple keystrokes and mouse directions.

C. Trend System

1. Supports plots of at least eight user selectable analog values in an x-y format, with each plot using a unique color. Trends shall use current or historical information with the ability to trend backward or forward from the initial time reference using a single command. Trend shall present precise numeric values for any point on the trace by moving the mouse on to the graphic trend line. The trend displays shall use shading or color change to emphasize when a particular point crosses a reference value.

2. Support transparent trends displays so that real-time and historical data can be directly compared; trend pens having different y-axis scales in engineering units; zoom functions selected by an operator selectable window; export of trend data compatible with standard spreadsheet packages; simultaneous display of historical data, data generated with standard spreadsheet packages, and SQL linked data from relational databases.

D. Database

1. Provide a menu-driven access program which allows the user to enter the database and add, delete, or modify any portion of the system to configure changes, including all graphics, group, station and point records, algorithms, report generation and system functions.

2. Provide a structured package such that the HMI database can be created or edited using standard text editors or spreadsheet software packages.

3. Provide means for HMI resident data mapping function blocks for access and control of all PLC data by bit and register and implement any City standard function blocks used for implementing standard City control or monitoring functions. Any City standard function blocks shall be provided to the PCSI at the System Coordination Workshops as specified in Section 13400.

E. Configuration

1. The system administrator shall have the capability of logging out of the current mode of operation, and with the proper password, enter the configuration mode.

2. The system administrator shall have the capability to modify group, station, and point records including all control, status, analog, pulse, auto control algorithms, limits, pseudo points, off-normal parameters, and related datum pursuant to a functional field device or process.

3. The system administrator shall have the capability to modify all graphic displays including operator screen parameters such as orientation of alarm queues, graphics etc.

4. The system administrator shall have the capability to modify all report generation parameters determining logged output.

5. The system administrator shall have the capability to modify password assignment and access/control restrictions for various PLC's and related graphics.

6. The system administrator shall have the capability to modify all alarm attributes and responsibility including assigning of priorities and queues into which alarms will arrive at the operator terminals.

F. Alarm System

1. Conditions in the field designated as alarm conditions shall report to the operator terminal, actuate an audible alarm, and provide a visual blinking image on the associated graphic page.

2. The alarm condition shall be a discrete input output change of state, uncommanded change of state for discrete outputs, analog values above and below limits, high or low analog rate-of-changes as defined in the database, marginal or failed communication link and failure of a hardware device such as screens, printers, input/output module, or other major device.

3. Alarms shall be assigned priority during database configuration, based on relative importance of the alarm condition. The priority will be able to be timed, so that unacknowledged alarms can raise priority if not acknowledged within a specified time period, allowing them to appear at the top of the queue.

4. Each alarm queue shall show the highest priority alarm on the screen. The queue shall be expanded to view up to ten alarms showing the alarming devices' condition in a flashing state, the priority, the time and the alarm arrived at the polling station (hour, minute, second) and the location of the alarm. The operator will have the option of acknowledging the alarm without clearing it, deferring it for reference, or clearing it from the screen.

5. Provide alarms in tabular listings selectable chronologically or by priority, acknowledged, unacknowledged or both. No alarms may be addressed without being able to be viewed.

G. Operator Control

1. Commands related to controlling field devices or system attributes shall conform to City standards.

H. Print Facilities

1. Printing is not required at the site. However, support capability to operate at least one alarm/event printer and one report printer. Alarm/Event printer shall be configurable to redirect event logs to a file.

2. Printouts or logs shall include the station location name, event, date, time, priority of event if applicable, and description.

I. Historical Data

1. System shall have the capability for historical data storage stored in an OBDC compliant file formats to facilitate access to operator activity, system events, alarm messages, and point values using relational-database compatible software for data analysis, reporting and archiving. Data storage shall be implemented as specified under Part 3 herein.

PART 3 EXECUTION

3.1 GENERAL INSTALLATION

A. Refer to Section 13400.

3.2 SCADA SYSTEM CONFIGURATION

A. General:

1. The PCSI shall match the look, feel, and standards of the existing City SCADA system including graphic screens, reports, database configuration, security, communication, and PLC programming to the greatest extent possible. Examples of City addressing approach, screen graphics, and reports will be provided to the PCSI after Award of Contract and further defined during the PCSI Coordination Workshops per Section 13400. The configuration specified herein refers to general features and elements of the graphic, alarming, reporting, and other features of the SCADA system. However, all specific system elements shall conform to the City standards to the greatest extent possible.

2. HMI Software presently in use at the WWTP is Inductive Automation, Ignition software. Software is resident on the City's existing HMI servers, fully virtualized using VMWare's Hypervisor Platform.

3. Refer to Section 13482 for control and system monitoring requirements.

4. All displays shall contain and continuously update the displayed process variables, date, and time of day. All process values shall be displayed in engineering units. All displays shall incorporate references to both instrumentation tag numbers and plant equipment numbers.

5. The system shall allow the operator to control equipment such as pumps and valves as defined in the control loop drawings and control loop descriptions. All control actions shall require a two step action to assure positive verification of each control operation.

6. Unless specifically noted otherwise, all timers, setpoints, alarm actuation levels, etc., shall be adjustable from the operator interface.

B. General Displays Requirements

1. Provide graphic, alarm summary, diagnostic, trends, and other displays in conformance with City standards as specified herein.

2. Graphic displays: The display shall depict basic the process diagrams with representative symbols for pumps, tanks, etc., combined with real time process variables or conditions. The displays shall be dynamic (i.e., symbols for a pump shall change color indicating run or stop or alarm, the volume of tanks shall be indicated by varying the height of the interior color of the tank symbol, etc.). All the current data in the database shall be available for graphic displays. All process variables shall be displayed on their associated display(s) with correct engineering units. Process variables shall display their associated data quality flags.

3. Alarm summary display: The display shall consist of all points currently in alarm and shall include the tag number, description, time of occurrence, and present status (high, low, normal, etc.). The alarm summary shall identify alarm points by severity by utilizing distinct colors for each severity category.

4. System diagnostic displays: The displays shall summarize the error status of all system devices capable of reporting errors (i.e., PLCs, computers, network equipment, printers, communication devices, etc.). The display shall indicate if an error is detected or a failure occurs. Status of primary and backup devices shall be indicated on display.

5. Trend displays: The trend display shall display the value of a maximum of eight assigned points versus time. Each point shall be trended in a different color. Each of the assigned points shall have a point identification number, point name, point description, current value, and instrument range displayed in the color used for its trend. The time period shall be selected and be either current or historical. The time period selected and time and date of start shall be displayed. The values displayed on a historical trend shall consist of the stored values for each variable trended. Current trends shall be updated at the scan frequency of the variable. A trend display shall not be considered a graphic display.

C. Project Specific Graphics:

1. Process graphic displays, shall be based on the P&ID's, site plan drawings, mechanical drawings and electrical drawings included in these contract documents. The graphic displays shall depict process flow streams, process structures, and all major items of process equipment and control devices in a schematic format.

2. Screen formats, colors, and layout shall match existing City standards for all graphical screens. General graphical requirements shall be as specified herein at a minimum.

3. The new process graphics shall be fully integrated into the security, trending, system alarm log, and data historian systems presently in place within the City SCADA system. Coordinate local logic, alarming, and historian systems with existing City platforms.

4. Control screens for pumps, gates, flow control valves, etc. shall be configured to be fully integrated into the City overall central SCADA graphical system menu structure. Coordinate with City staff to integrate the new graphical interface screens into the system control hierarchy, screen navigation, security hierarchy, failsafe logic, positive operator verification of control commands, etc.

5. The PCSI shall be responsible for providing at a minimum the following graphic screens for the work performed under this Contract. Final details of the graphic screen standards, formats, and development criteria shall be reviewed and finalized at the SCADA coordination workshops specified under Section 13400.

    a. The present SCADA central system at the Brentwood WWTP utilizes approximately 50 graphic screens for monitoring and control of the facility. The PCSI shall utilize these existing screens as templates for the new and modified graphics developed under this Project. Provide existing screen modifications including data addressing changes with an assumed 25% modified data points on each screen.

b. Incorporate all new SCADA monitoring and alarms into the existing platform's standard alarm summary screens, status screens, navigation screens, and other auxiliary graphics to provide a fully configured, integrated, and functional system

c. Provide additional new and modified graphic screens as necessary for the work required under this Contract as specified and directed by the City. The new or modified screens shall be developed by the PCSI to incorporate the new elements at the WWTP as shown on the Drawings. Specifics of the contents and layouts of the screens shall be developed and coordinated during the SCADA coordination workshops specified in Section 13400. Where common train screens are anticipated, the base or typical screen for the trains shall count for only one of the specified additional screens.

1) Modifications to the Overall System Navigation Screen (physical or hierarchical tree representation)

2) Modifications to the existing Tabular Screen Index

3) New and modified PLC and Control Network Diagnostics: two screens

4) Revised Dewatered Sludge Conveyors: two screens

5) Oxidation Ditches 1 and 2 (liquid and air): five screens

6) Aeration Basins 3 and 4 (liquid and air): five screens

7) Blower Blowers: one per blower, four total (coordinated with Blower/Aeration system supplier Section 11502 and Section 13550)

8) Aeration System: two screens (coordinated with Blower/Aeration system supplier Section 11502 and Section 13550)

9) Secondary Clarifier 3: two screens

10) RAS pumping modifications: three screens

11) Scum pumping modifications: three screens

12) RAS pump station sump pumps: two screens

13) WAS storage: five screens

14) New Dewatering, Dryer, and Conveyors: 20 screens (coordinated with Dryer system supplier – Section 11600)

15) Modifications to the Chlorine Contact Basin: four screens

16) Modifications to the Filter Pumping: four screens

17) Miscellaneous systems: HVAC, electrical distribution, power monitoring: five screens

18) Other Additional Screens

a) Include provision for up to 15 additional process screens monitoring and control graphic screens

b) Content of additional screens to be determined during SCADA coordination workshops

D. A graphic screen shall be defined as the process specific graphics, pump station overall performance parameters, individual pump operating parameters, etc. Secondary pop-up/pull-down screens used for control, alarm acknowledgement, etc. shall be counted as being part of an individual primary graphic screen Screens shall comply with the control requirements as defined under Section 13482.

E. Historical Data Management

1. The following features shall be provided for processing and storage of system historical data:

a. Facility historical logging, archiving, and reporting shall be performed at the City's existing SCADA central at the WWTP. The real time instantaneous values shall be integrated and stored in a historical log file on the virtualized servers, using the Ignition based HMI Historian application at the specified sampling rates per Section 13482.

b. Provide for storage of all historical facility operations data at the new WWTP as coordinated with City personnel at the SCADA Coordination Workshops. Refer also to Section 13482.

c. Storage of system performance data shall be provided as coordinated with City personnel at the SCADA Coordination Workshops. Performance data shall be suitable for use by the City Asset Management system and shall include but not be limited to equipment run times for all equipment with runtimes monitored, equipment start counts for all equipment with run times monitored, and individual equipment, electrical power monitoring, switchgear status, and other performance and diagnostic data per Division 16. Refer also to Section 13482.

d. Develop system trending functions. Coordinate historical data trending capability with the City at the system workshops to implement full local trending capability for all new data provided under this Contract.

F. Reports**:**

1. System reporting shall be performed at the City's SCADA central at the WWTP under the existing virtualized servers running Inductive Automation, Ignition software.

2. Provide preconfigured database queries from either realtime or historian database as required for the specific report.

3. Assume modification of existing reports to incorporate additional WAS, RAS, Filtered/Recycled Water, sludge handling, Water Quality reports, and other existing processes modified under this Project. Assume up to ten (10) existing reports will be modified under this Contract.

4. Assume new reports provided to present operational and performance details for Oxidation Ditches, Aeration Basins, new RAS Pump Station, new Dryer System operation and other new processes modified under this Project. Assume development of up to fifteen (15) new reports under this Contract.

5. Existing report modifications and new report format and content shall be developed during the SCADA coordination meetings as specified under Section 13400.

3.3 TESTING

A. Perform system testing as specified under Section 13490.

END OF SECTION

SECTION 13422 – LOCAL AREA NETWORK SYSTEMS

PART 1 GENERAL

1.1 SCOPE OF WORK

A. Provide local area network equipment, and ancillary network and communication equipment where shown on the Drawings and as specified in these Specifications.

B. The Contract Documents are a single integrated document, and as such all Divisions and Sections apply. It is the responsibility of the Contractor and subcontractors to review all sections to insure a complete and coordinated project.

C. Provide manufacturer's standard compatible software for all network components where specified in these Specifications. All software provided shall match indicated City networking software standards

D. All software provided shall be licensed to the City.

E. Furnish and install communication and networking equipment including fiber optic interfaces, network switches, firewalls, and other equipment as shown on the Drawings and specified in these Specifications.

F. The Plans and Specifications define multiple separate and distinct Ethernet networks. Where equipment is required to interface with multiple networks, a separate network interface card or modules shall be installed for each network connections. There shall be no physical interconnection or direct routing of data between the separate networks. The separate networks include:

1. PLC Network
2. SCADA Network
3. City's Business Network (also referred to as the City Network or Business Network)
4. Remote I/O Networks (separate networks for each Process Area PLC system)
5. Equipment Monitoring data network/historian network
6. Security System Network (provision for future)
7. Telephone/Data Network (provision for future)
8. Closed Circuit Television (provision for future)

1.2 RELATED SECTIONS

A. Section 11502 – Geared Single Stage Centrifugal Blower Packages

B. Section 11600 – Biosolids Dryer System

C. Section 13400 – Common Work Results Process Instrumentation and Controls

D. Section 13420 – Control Panels and Hardware

E. Section 13421 – Programmable Logic Controllers and Computer Control Systems

F. Section 13482 – Process Control Descriptions

G. Section 13490 – Commissioning of Process Control Systems

H. Section 13550 – Aeration Control System

I. Section 14552 – Screw Conveyors – Modifications and Improvements

J. Section 16120 – Conductors and Cables (600 Volt Maximum)

K. Section 16122 – Fiber Optic Cable and Equipment

L. Section 16260 – Low Voltage Adjustable Speed Motor Controllers

M. Section 16265 – Low Voltage Reduced Voltage Solid State Starters

N. Section 16290 – Electrical Power Monitoring System

O. Section 16350 – Medium Voltage Switchgear

P. Section 16436 – 480 Volt Switchgear

Q. Section 16442 – Motor Control Centers

1.3 SUBMITTALS

A. All submittals shall be in accordance with Section 01340 Section 13400

B. Submit catalog data and characteristics of fiber optic system components as specified in these Specifications including panel resident fibers, connectors, patch panels, converters, and other equipment. Submit

1. Descriptive literature and product information of fiber optic switches and networking equipment specified.

2. Submit certification from the PLC manufacturer specified under Section 13421 that the networking components provided shall be compatible with and achieve rated network performance when installed in conformance with the manufacturer's recommendations.

3. Local fiber optic jumpers and cable descriptive product information including transmission parameters, jacket properties, and physical attributes (maximum short term and long term tensile loads).

4. Submit results of field acceptance tests and installation tests for review.

5. Submit final copies of any configuration files and/or programs developed for this project in PDF and native electronic format incorporated into the system O&M Manuals as specified under Section 13400.

1.4 RELATED WORK PERFORMED BY OTHERS

A. Refer to Section 13400

B. The PCS network hardware components for the Blower System and Aeration Control System, as delineated on the Drawings and described in specification 11502 and Section 13550 respectively shall be provided and programmed by the Aeration Control System Supplier. The system supplier shall provide programming and configuration for the associated PLCs, OITs, and network components.

C. The PCS network and hardware components for the Dryer Systems, as delineated on the Drawings and described in Section 11600 shall be provided and programmed by the Dryer System Supplier. The system supplier shall provide programming and configuration for the associated PLCs, OITs, and network components.

D. The PCS network and hardware components for the Conveyor Systems, as delineated on the Drawings and described in Section 14552, shall be provided and programmed by the Conveyor System Supplier respectively. The system supplier shall provide programming and configuration for the associated PLCs, OITs, and network components.

1.5 MAINTENANCE

A. As a minimum, provide the following:

1. Ten percent (10%) (minimum of two) spare Ethernet network switches of each type provided under this Contract.

2. Ten percent (10%) (minimum of two) spare communication interface devices of each type provided under this Contract.

3. Ten percent (10%) (minimum of two) spare power supplies of each type provided under this Contract.

4. Ten percent (10%) (minimum of 2 each) of each type of miscellaneous components, switches, lights, cable connectors, fiber optic converters, and other field replaceable system components provided under this Contract.

B. All spare parts shall be carefully packed in cartons, labeled with indelible markings, and shall be adequately treated for a long period of storage. Complete ordering information including manufacturer's part number, part ordering information including manufacturer, part number, part name, and equipment name and number(s) for which the part is to be used shall be supplied with the required spare parts. The spare parts shall be delivered and stored in a location directed by City.

PART 2 PRODUCTS

2.1 EQUIPMENT – GENERAL

A. Equipment shall be designed to operate on a 60 Hertz alternating current power source at a nominal 120 volts, plus or minus 10 percent, except where specifically noted. Regulators and power supplies required for compliance with the above shall be provided. Where equipment requires voltage regulation, constant voltage transformers shall be supplied.

B. Materials and equipment used shall be UL approved wherever such approved equipment and materials are available.

C. The system shall be designed and constructed to withstand the demands of real time process management and control.

D. All equipment, cabinets and devices furnished hereunder shall be heavy-duty type, designed for continuous industrial service. The system shall contain products of a single manufacturer, insofar as possible, and shall consist of equipment models that are currently in production. All equipment provided shall be of modular construction and shall be capable of field expansion through the installation of plug-in circuit cards or additional cabinets.

E. All equipment furnished shall be designed and constructed so that in the event of power interruption, or temperatures outside the operational range, the systems specified hereunder shall go through an orderly shutdown with no loss of memory, and resume normal operation without manually resetting when power is restored.

F. All software required to achieve the functionality described in the Specifications shall be provided. All software provided under this Contract shall be licensed to the City of Brentwood. Coordinate with the City for licensing details and points of contact.

G. Only software platforms and releases approved by the City for use shall be installed.

H. Provide all software updates to networking programming, diagnostic, and management software throughout the construction period. Installation of network software shall only be implemented upon express written direction from the City as specified in Section 13400.

2.2 COMMUNICATION NETWORKS

A. The PCSI shall furnish and install the complete IEEE 802.3 compliant Ethernet Local Area Networks (LANs) capable of supporting communications between all switches, HMIs, PLCs as shown on the system architecture block diagram. The PCSI shall furnish all necessary cables, face plates, connectors, modems, transceivers, repeaters, modules, splice kits, etc. required for a complete and operational LAN. The system shall be designed to accommodate an increase of 100% PLC units and workstations.

B. The maximum Ethernet communication scan-time shall be calculated with all devices on line and with the maximum allowable scan time of two (2) seconds for obtaining all available Ethernet data. PCSI shall coordinate network scan and access times with suppliers of other network resident equipment as specified in Divisions 11, 13, 14, and 16.

C. Alarms shall be provided on each computer to alert plant personnel of communication link cable break, stalled or malfunctioning communication director and security disconnect of malfunctioning remote systems units.

D. Provide additional, spare network taps as part of each Ethernet network to connect a laptop computer to the networks. The taps must be easily accessible for connectivity.

E. Control Panel Mounted (Industrial Grade) Ethernet Switches

1. Where installed within PLC control panels or where indicated on the Drawings, provide industry-standard ultra wide IEEE 802.3u 100Base-TX and 100Base-FX

autosensing Ethernet switches supporting Fast Ethernet communications over both fiber optic (FO) and copper cables. Provide managed Ethernet switches with a minimum of six 100Base-TX ports and two 100Base-FX ports or as required by the specific applications shown on the drawings plus 25% spare ports whichever is greater.

2. Power supply shall be redundant 24VDC inputs.

3. FO ports shall be single-mode type with type ST connectors. Switches shall be suitable for installation in a self-healing ring topology network and include STP, RSTP, and MSTP protocols for redundancy.

4. Switch shall be standard DIN rail mount type for industrial application having a minimum operating temperature of 60 degree C, and listed for installation in a UL508 control panel.

5. Switches shall be suitable for and compatible with power over Ethernet devices including closed circuit television video cameras as specified in Section 13701.

6. Switches shall include an alarm relay contact output rated for 1 amp at 24VDC.

7. Switches shall be Moxa EDS-500 series, or equal

F. Control Panel Mounted Remote I/O Network Ethernet Switches

1. Where installed and connected to PLC Remote I/O networks, as indicated on the Drawings, provide Schneider Electric ConneXium series extended managed switches, no equal, as required by the application.

2. Remote I/O network switches shall be ultra wide IEEE 802.3u 100Base-TX and 100Base-FX autosensing Ethernet switches supporting Schneider Electric Remote I/O and Distributed I/O communications over both fiber optic (FO) and copper cables. Provide remote I/O Ethernet switches with a minimum of six 100Base-TX ports and two 100Base-FX ports or as required by the specific applications shown on the drawings plus 25% spare ports whichever is greater.

3. Power supply shall be redundant 24VDC inputs.

4. FO ports shall be single-mode type with type ST connectors. Switches shall be suitable for installation in a self-healing ring topology network and include STP, RSTP, and MSTP protocols for redundancy.

5. Switch shall be standard DIN rail mount type for industrial application having a minimum operating temperature of 60 degree C, and listed for installation in a UL508 control panel.

6. Switches shall be preconfigured by the factory for the installed application. Configuration files for each Remote I/O Network switch shall be provided to the City prior to installation.

7. Switches shall include an alarm relay contact output rated for 1 amp at 24VDC.

8. Switches shall be ConneXium Extended Ethernet TCP/IP managed switches, no equal.

G. Rack Mounted Ethernet Switches

1. Where installed in Communication Rack Panels or where indicated on the Drawings, provide industry-standard ultra wide IEEE 802.3u 100Base-TX and 100Base-FX autosensing Ethernet switches supporting Fast Ethernet communications over both fiber optic (FO) and copper cables. Provide managed Ethernet switches with number and type of ports as shown on the Drawings, plus 25% spare ports, minimum of two, of each type.

2. Power supply shall be redundant 24VDC inputs.

3. FO ports shall be single-mode type with type LC connectors. Switches shall be suitable for managing a self-healing ring topology network and include STP, RSTP, and MSTP protocols for redundancy.

4. Switch shall be standard 19” rack mount design having minimum operating temperature of 40 degree C,

5. Switches shall be suitable for and compatible with power over Ethernet devices including closed circuit television video cameras as specified in Section 13701.

6. Switches shall be Cisco 2960 series; Hirschmann, or equal, to match existing equipment.

H. Wallmount 19” Communication Equipment Mounting Rack

1. Provide wall mounted communications racks installed to allow full access to both front and rear of rack mounted components.

2. Provide UL Listed rack, welded construction, 24-inch (usable) depth, vented, with front and rear lockable and removable doors. Front door shall have smoked plexiglass inspection window. Provide wall mounted racks with minimum 24 rack unit capacity and a minimum of two standard adjustable threaded rackrails marked in rackspace increments.

3. Provide wall mounted communications rack as manufactured by OCC, Model WC2438; Middle Atlantic Products; Rittal; or approved equal.

I. Free Standing, Fixed 19” Communication Equipment Mounting Rack

1. Where shown on the Drawings mounted away from walls, provide fixed floor mounted communications racks allowing full access to both front and rear of rack mounted components.

2. Provide UL Listed rack, welded construction, 30-inch (usable) depth, with vented lockable doors (both front and rear), built-in cable lacing points, internal cable tie points, and standard adjustable threaded rackrail marked in rackspace increments.

3. Provide rack with 3000 pound weight capacity, seismically certified per the 2010 2012 International Building Code.

4. Provide pivot type communications rack as manufactured by Middle Atlantic Products SNE Series; Rittal; or approved equal.

J. Ethernet 10/100BASE-T/TX Cable: As specified in Section 16120.

K. Multi-mode fiber patch cords: As specified in Section 16122.

L. Fiber Optic to Copper Converter: As specified in Section 16122.

PART 3 EXECUTION

3.1 GENERAL INSTALLATION

A. Refer to Section 13400.

3.2 FIBER OPTIC CABLE INSTALLATION

A. Install in conformance with Section 16122.

3.3 NETWORK CONFIGURATION

A. Network components shall be configured as shown on the Drawings and in cooperation with the City's Information Technology (IT) staff.

B. Components installed on the City Business Network shall be configured with addresses and subnets as directed by the City's IT staff. The contractor shall submit their proposed configuration and network addressing schemes to the City's IT staff for approval prior to factory testing.

3.4 TESTING

A. Perform system testing as specified under Section 13400.

END OF SECTION

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SECTION 13430 – FIELD INSTRUMENT INDEX

PART 1 GENERAL

1.1 SCOPE OF WORK

A. The Field Instrument Index is included for reference only. Only major instruments are included in the Field Instrument Index and miscellaneous switches, relays, valves, signal conditioners, process seals, manifolds, and auxiliary devices are not included. Providing all instruments and devices necessary for a fully functioning system shall be the responsibility of the PCSI, based on the Process Control Descriptions per Section 13482, auxiliary device requirements, and spare requirements as shown on the Drawings and specified in these Specifications.

1.2 RELATED WORK

A. Section 13400 – Common Work Results Process Instrumentation and Controls

B. Section 13431 – Instrumentation and Controls - Analytical Devices

C. Section 13432 – Instrumentation and Controls - Flow Measurement

D. Section 13433 – Instrumentation and Controls - Level Measurement

E. Section 13434 – Instrumentation and Controls - Pressure Measurement

F. Section 13435 – Instrumentation and Controls - Temperature Measurement

1.3 SUBMITTALS

A. As specified in Section 13400.

B. The PCSI shall revise the Field Instrument Index to include the manufacturer, complete model number, and the control panel or motor control center to which the instrument is connected.

END OF SECTION

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13430 APPENDIX A
FIELD INSTRUMENT LIST

INSTRUMENT TAG NO.	DESCRIPTIONS/LOCATION	RANGE	SETPOINT NOTE 5	UNITS	SPEC. REFERENCE		P&ID REF.	REMARK
					SECTION	PARAGRAPH		
14-SSL-P50	Dewatered Sludge Conveyor 1 Zero Speed Switch				14552	2.2G	14-I-01	Provided by Conveyor Supplier. Note 6
14-SSL-P55	Dewatered Sludge Conveyor 2 Zero Speed Switch				14552	2.2G	14-I-01	Provided by Conveyor Supplier. Note 6
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14-SSL-P60	Dewatered Sludge Conveyor 3 Zero Speed Switch				14552	2.2G	14-I-02	Provided by Conveyor Supplier. Note 6
14-SSL-P65	Dewatered Sludge Conveyor 4 Zero Speed Switch				14552	2.2G	14-I-02	Provided by Conveyor Supplier. Note 6
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21-AE/AIT-E10-1	Oxidation Ditch 1 Oxic Zone 1E Dissolved Oxygen Analyzer	0-10	2	mg/L	13420	2.1	21-I-01	
21-AE/AIT-E10-2	Oxidation Ditch 1 Oxic Zone 1F Dissolved Oxygen Analyzer	0-10	2	mg/L	13420	2.1	21-I-01	
21-AE/AIT-E10-3	Oxidation Ditch 1 Oxic Zone 1G Dissolved Oxygen Analyzer	0-10	2	mg/L	13420	2.1	21-I-01	
21-AE/AIT-E10-4	Oxidation Ditch 1 Oxic Zone 1H Dissolved Oxygen Analyzer	0-10	2	mg/L	13420	2.1	21-I-01	
21-AE/AIT-E10-5	Oxidation Ditch 1 Oxic Zone 1H Ammonium Analyzer	0-20	8.5	mg/L	13420	2.2	21-I-01	
21-TSH-E17	Wall Pump 1-1 High Temperature Switch				16220	2.7	21-I-01	Provided by Pump Motor Supplier
21-TSH-E18	Wall Pump 1-2 High Temperature Switch				16220	2.7	21-I-01	Provided by Pump Motor Supplier
21-TSH-E19	Mixer 1-7 High Temperature Switch				16220	2.7	21-I-01	Provided by Mixer Motor Supplier
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21-FE/FIT-E20	Oxidation Ditch 1 Oxic Zone 1E Air Flow Sensor/Transmitter	0-3000	400	SCFM	13550	2.4	21-I-02	Provided by Aeration System Supplier
21-FE/FIT-E21	Oxidation Ditch 1 Oxic Zone 1F Air Flow Sensor/Transmitter	0-3000	350	SCFM	13550	2.4	21-I-02	Provided by Aeration System Supplier
21-FE/FIT-E22	Oxidation Ditch 1 Oxic Zone 1G Air Flow Sensor/Transmitter	0-3000	550	SCFM	13550	2.4	21-I-02	Provided by Aeration System Supplier
21-FE/FIT-E23	Oxidation Ditch 1 Oxic Zone 1H Air Flow Sensor/Transmitter	0-3000	225	SCFM	13550	2.4	21-I-02	Provided by Aeration System Supplier
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22-AE/AIT-E10-1	Oxidation Ditch 2 Oxic Zone 2E Dissolved Oxygen Analyzer	0-10	2	mg/L	13431	2.1	22-I-01	
22-AE/AIT-E10-2	Oxidation Ditch 2 Oxic Zone 2F Dissolved Oxygen Analyzer	0-10	2	mg/L	13431	2.1	22-I-01	
22-AE/AIT-E10-3	Oxidation Ditch 2 Oxic Zone 2G Dissolved Oxygen Analyzer	0-10	2	mg/L	13431	2.1	22-I-01	
22-AE/AIT-E10-4	Oxidation Ditch 2 Oxic Zone 2H Dissolved Oxygen Analyzer	0-10	2	mg/L	13431	2.1	22-I-01	
22-AE/AIT-E10-5	Oxidation Ditch 2 Oxic Zone 2H Ammonium Analyzer	0-20	8.5	mg/L	13431	2.2	22-I-01	
22-TSH-E17	Wall Pump 2-1 High Temperature Switch				16220	2.7	22-I-01	Provided by Pump Motor Supplier
22-TSH-E18	Wall Pump 2-2 High Temperature Switch				16220	2.7	22-I-01	Provided by Pump Motor Supplier
22-TSH-E19	Mixer 2-7 High Temperature Switch				16220	2.7	22-I-01	Provided by Mixer Motor Supplier
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22-FE/FIT-E20	Oxidation Ditch 2 Oxic Zone 2E Air Flow Sensor/Transmitter	0-3000	400	SCFM	13550	2.4	22-I-02	Provided by Aeration System Supplier
22-FE/FIT-E21	Oxidation Ditch 2 Oxic Zone 2F Air Flow Sensor/Transmitter	0-3000	350	SCFM	13550	2.4	22-I-02	Provided by Aeration System Supplier
22-FE/FIT-E22	Oxidation Ditch 2 Oxic Zone 2G Air Flow Sensor/Transmitter	0-3000	550	SCFM	13550	2.4	22-I-02	Provided by Aeration System Supplier
22-FE/FIT-E23	Oxidation Ditch 2 Oxic Zone 2H Air Flow Sensor/Transmitter	0-3000	225	SCFM	13550	2.4	22-I-02	Provided by Aeration System Supplier
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23-TSH-E5	Wall Pump 3-1 High Temperature Switch				16220	2.7	23-I-01	Provided by Pump Motor Supplier
23-TSH-E6	Mixer 3-5 High Temperature Switch				16220	2.7	23-I-01	Provided by Mixer Motor Supplier
23-AE/AIT-E10-1	Aeration Basin 3 Oxic Zone 3E Dissolved Oxygen Analyzer	0-10	2	mg/L	13431	2.1	23-I-01	
23-AE/AIT-E10-2	Aeration Basin 3 Oxic Zone 3F Dissolved Oxygen Analyzer	0-10	2	mg/L	13431	2.1	23-I-01	
23-AE/AIT-E10-3	Aeration Basin 3 Oxic Zone 3G Dissolved Oxygen Analyzer	0-10	2	mg/L	13431	2.1	23-I-01	
23-AE/AIT-E10-4	Aeration Basin 3 Oxic Zone 3H Dissolved Oxygen Analyzer	0-10	2	mg/L	13431	2.1	23-I-01	
23-AE/AIT-E10-5	Aeration Basin 3 Oxic Zone 3H Ammonium Analyzer	0-20	8.5	mg/L	13431	2.2	23-I-01	
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23-FE/FIT-E20	Aeration Basin 3 Oxic Zone 3E Air Flow Sensor/Transmitter	0-2000	225	SCFM	13550	2.4	23-I-02	Provided by Aeration System Supplier
23-FE/FIT-E21	Aeration Basin 3 Oxic Zone 3F Air Flow Sensor/Transmitter	0-2000	200	SCFM	13550	2.4	23-I-02	Provided by Aeration System Supplier
23-FE/FIT-E22	Aeration Basin 3 Oxic Zone 3G Air Flow Sensor/Transmitter	0-2000	200	SCFM	13550	2.4	23-I-02	Provided by Aeration System Supplier
23-FE/FIT-E23	Aeration Basin 3 Oxic Zone 3H Air Flow Sensor/Transmitter	0-2000	175	SCFM	13550	2.4	23-I-02	Provided by Aeration System Supplier
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24-TSH-E5	Wall Pump 4-1 High Temperature Switch				16220	2.7	24-I-01	Provided by Pump Motor Supplier
24-TSH-E6	Mixer 4-5 High Temperature Switch				16220	2.7	24-I-01	Provided by Mixer Motor Supplier
24-AE/AIT-E10-1	Aeration Basin 4 Oxic Zone 4E Dissolved Oxygen Analyzer	0-10	2	mg/L	13431	2.1	24-I-01	
24-AE/AIT-E10-2	Aeration Basin 4 Oxic Zone 4F Dissolved Oxygen Analyzer	0-10	2	mg/L	13431	2.1	24-I-01	
24-AE/AIT-E10-3	Aeration Basin 4 Oxic Zone 4G Dissolved Oxygen Analyzer	0-10	2	mg/L	13431	2.1	24-I-01	
24-AE/AIT-E10-4	Aeration Basin 4 Oxic Zone 4H Dissolved Oxygen Analyzer	0-10	2	mg/L	13431	2.1	24-I-01	
24-AE/AIT-E10-5	Aeration Basin 4 Oxic Zone 4H Ammonium Analyzer	0-20	8.5	mg/L	13431	2.2	24-I-01	
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FIELD INSTRUMENT LIST

INSTRUMENT TAG NO.	DESCRIPTIONS/LOCATION	RANGE	SETPOINT NOTE 5	UNITS	SPEC. REFERENCE		P&ID REF.	REMARK
					SECTION	PARAGRAPH		
24-FE/FIT-E20	Aeration Basin 4 Oxic Zone 4E Air Flow Sensor/Transmitter	0-2000	225	SCFM	13550	2.4	24-I-02	Provided by Aeration System Supplier
24-FE/FIT-E21	Aeration Basin 4 Oxic Zone 4F Air Flow Sensor/Transmitter	0-2000	200	SCFM	13550	2.4	24-I-02	Provided by Aeration System Supplier
24-FE/FIT-E22	Aeration Basin 4 Oxic Zone 4G Air Flow Sensor/Transmitter	0-2000	200	SCFM	13550	2.4	24-I-02	Provided by Aeration System Supplier
24-FE/FIT-E23	Aeration Basin 4 Oxic Zone 4H Air Flow Sensor/Transmitter	0-2000	175	SCFM	13550	2.4	24-I-02	Provided by Aeration System Supplier
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27-TE-E10-1	Blower 1 Gear Box Temperature Sensor 1	NOTE 2			13435	2.1	27-I-01	Provided by Blower System Supplier - Note 2
27-TE-E10-2	Blower 1 Gear Box Temperature Sensor 2	NOTE 2			13435	2.1	27-I-01	Provided by Blower System Supplier - Note 2
27-VT-E10	Blower 1 Gear Box Vibration Transmitter	NOTE 2			11502	2.19	27-I-01	Provided by Blower System Supplier - Note 2
27-TE-E10-3	Blower 1 Gear Box Temperature Sensor 3	NOTE 2			13435	2.1	27-I-01	Provided by Blower System Supplier - Note 2
27-TE-E10-4	Blower 1 Gear Box Temperature Sensor 4	NOTE 2			13435	2.1	27-I-01	Provided by Blower System Supplier - Note 2
27-TSH-E10	Blower 1 High Temperature Switch	NOTE 2			16220	2.7	27-I-01	Provided by Blower System Supplier - Note 2
27-PSLL-E10	Blower 1 Gear Box Cooling Loop Low Low Pressure Switch	NOTE 2			13434	2.3	27-I-01	Provided by Blower System Supplier - Note 2
27-PT-E10	Blower 1 Gear Box Cooling Loop Pressure Transmitter	NOTE 2			13434	2.2	27-I-01	Provided by Blower System Supplier - Note 2
27-TT-E10	Blower 1 Gear Box Cooling Loop Temperature Transmitter	NOTE 2			13435	2.1	27-I-01	Provided by Blower System Supplier - Note 2
27-PSH-E10	Blower 1 Gear Box Cooling Loop Filter High Pressure Switch	NOTE 2			13434	2.3	27-I-01	Provided by Blower System Supplier - Note 2
27-PDT-E11	Blower 1 Inlet Filter Differential Pressure Transmitter	NOTE 2			13434	2.1	27-I-01	Provided by Blower System Supplier - Note 2
27-TT-E12	Blower 1 Inlet Temperature Transmitter	NOTE 2			13435	2.1	27-I-01	Provided by Blower System Supplier - Note 2
27-PSH-E12	Blower 1 Inlet High Pressure Switch	NOTE 2			13434	2.3	27-I-01	Provided by Blower System Supplier - Note 2
27-PDT-E15	Blower 1 Differential Pressure Transmitter	NOTE 2			13434	2.1	27-I-01	Provided by Blower System Supplier - Note 2
27-TT-E17	Blower 1 Discharge Temperature Transmitter	NOTE 2			13435	2.2	27-I-01	Provided by Blower System Supplier - Note 2
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27-TE-E20-1	Blower 2 Gear Box Temperature Sensor 1	NOTE 2			13435	2.1	27-I-01	Provided by Blower System Supplier - Note 2
27-TE-E20-2	Blower 2 Gear Box Temperature Sensor 2	NOTE 2			13435	2.1	27-I-01	Provided by Blower System Supplier - Note 2
27-VT-E20	Blower 2 Gear Box Vibration Transmitter	NOTE 2			11502	2.19	27-I-01	Provided by Blower System Supplier - Note 2
27-TE-E20-3	Blower 2 Gear Box Temperature Sensor 3	NOTE 2			13435	2.1	27-I-01	Provided by Blower System Supplier - Note 2
27-TE-E20-4	Blower 2 Gear Box Temperature Sensor 4	NOTE 2			13435	2.1	27-I-01	Provided by Blower System Supplier - Note 2
27-TSH-E20	Blower 2 High Temperature Switch	NOTE 2			16220	2.7	27-I-01	Provided by Blower System Supplier - Note 2
27-PSLL-E20	Blower 2 Gear Box Cooling Loop Low Low Pressure Switch	NOTE 2			13434	2.3	27-I-01	Provided by Blower System Supplier - Note 2
27-PT-E20	Blower 2 Gear Box Cooling Loop Pressure Transmitter	NOTE 2			13434	2.2	27-I-01	Provided by Blower System Supplier - Note 2
27-TT-E20	Blower 2 Gear Box Cooling Loop Temperature Transmitter	NOTE 2			13435	2.1	27-I-01	Provided by Blower System Supplier - Note 2
27-PSH-E20	Blower 2 Gear Box Cooling Loop Filter High Pressure Switch	NOTE 2			13434	2.3	27-I-01	Provided by Blower System Supplier - Note 2
27-PDT-E21	Blower 2 Inlet Filter Differential Pressure Transmitter	NOTE 2			13434	2.1	27-I-01	Provided by Blower System Supplier - Note 2
27-TT-E22	Blower 2 Inlet Temperature Transmitter	NOTE 2			13435	2.1	27-I-01	Provided by Blower System Supplier - Note 2
27-PSH-E22	Blower 2 Inlet High Pressure Switch	NOTE 2			13434	2.3	27-I-01	Provided by Blower System Supplier - Note 2
27-PDT-E25	Blower 2 Differential Pressure Transmitter	NOTE 2			13434	2.1	27-I-01	Provided by Blower System Supplier - Note 2
27-TT-E27	Blower 2 Discharge Temperature Transmitter	NOTE 2			13435	2.2	27-I-01	Provided by Blower System Supplier - Note 2
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27-TE-E30-1	Blower 3 Gear Box Temperature Sensor 1	NOTE 2			13435	2.1	27-I-02	Provided by Blower System Supplier - Note 2
27-TE-E30-2	Blower 3 Gear Box Temperature Sensor 2	NOTE 2			13435	2.1	27-I-02	Provided by Blower System Supplier - Note 2
27-VT-E30	Blower 3 Gear Box Vibration Transmitter	NOTE 2			11502	2.19	27-I-02	Provided by Blower System Supplier - Note 2
27-TE-E30-3	Blower 3 Gear Box Temperature Sensor 3	NOTE 2			13435	2.1	27-I-02	Provided by Blower System Supplier - Note 2
27-TE-E30-4	Blower 3 Gear Box Temperature Sensor 4	NOTE 2			13435	2.1	27-I-02	Provided by Blower System Supplier - Note 2
27-TSH-E30	Blower 3 High Temperature Switch	NOTE 2			16220	2.7	27-I-02	Provided by Blower System Supplier - Note 2
27-PSLL-E30	Blower 3 Gear Box Cooling Loop Low Low Pressure Switch	NOTE 2			13434	2.3	27-I-02	Provided by Blower System Supplier - Note 2
27-PT-E30	Blower 3 Gear Box Cooling Loop Pressure Transmitter	NOTE 2			13434	2.2	27-I-02	Provided by Blower System Supplier - Note 2
27-TT-E30	Blower 3 Gear Box Cooling Loop Temperature Transmitter	NOTE 2			13435	2.1	27-I-02	Provided by Blower System Supplier - Note 2
27-PSH-E30	Blower 3 Gear Box Cooling Loop Filter High Pressure Switch	NOTE 2			13434	2.3	27-I-02	Provided by Blower System Supplier - Note 2
27-PDT-E31	Blower 3 Inlet Filter Differential Pressure Transmitter	NOTE 2			13434	2.1	27-I-02	Provided by Blower System Supplier - Note 2
27-TT-E32	Blower 3 Inlet Temperature Transmitter	NOTE 2			13435	2.1	27-I-02	Provided by Blower System Supplier - Note 2
27-PSH-E32	Blower 3 Inlet High Pressure Switch	NOTE 2			13434	2.3	27-I-02	Provided by Blower System Supplier - Note 2
27-PDT-E35	Blower 3 Differential Pressure Transmitter	NOTE 2			13434	2.1	27-I-02	Provided by Blower System Supplier - Note 2
27-TT-E37	Blower 3 Discharge Temperature Transmitter	NOTE 2			13435	2.2	27-I-02	Provided by Blower System Supplier - Note 2
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27-TE-E40-1	Blower 4 Gear Box Temperature Sensor 1	NOTE 2			13435	2.1	27-I-02	Provided by Blower System Supplier - Note 2
27-TE-E40-2	Blower 4 Gear Box Temperature Sensor 2	NOTE 2			13435	2.1	27-I-02	Provided by Blower System Supplier - Note 2

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INSTRUMENT TAG NO.	DESCRIPTIONS/LOCATION	RANGE	SETPOINT NOTE 5	UNITS	SPEC. REFERENCE		P&ID REF.	REMARK
					SECTION	PARAGRAPH		
27-VT-E40	Blower 4 Gear Box Vibration Transmitter	NOTE 2			11502	2.19	27-I-02	Provided by Blower System Supplier - Note 2
27-TE-E40-3	Blower 4 Gear Box Temperature Sensor 3	NOTE 2			13435	2.1	27-I-02	Provided by Blower System Supplier - Note 2
27-TE-E40-4	Blower 4 Gear Box Temperature Sensor 4	NOTE 2			13435	2.1	27-I-02	Provided by Blower System Supplier - Note 2
27-TSH-E40	Blower 4 High Temperature Switch	NOTE 2			16220	2.7	27-I-02	Provided by Blower System Supplier - Note 2
27-PSLL-E40	Blower 4 Gear Box Cooling Loop Low Low Pressure Switch	NOTE 2			13434	2.3	27-I-02	Provided by Blower System Supplier - Note 2
27-PT-E40	Blower 4 Gear Box Cooling Loop Pressure Transmitter	NOTE 2			13434	2.2	27-I-02	Provided by Blower System Supplier - Note 2
27-TT-E40	Blower 4 Gear Box Cooling Loop Temperature Transmitter	NOTE 2			13435	2.1	27-I-02	Provided by Blower System Supplier - Note 2
27-PSH-E40	Blower 4 Gear Box Cooling Loop Filter High Pressure Switch	NOTE 2			13434	2.3	27-I-02	Provided by Blower System Supplier - Note 2
27-PDT-E41	Blower 4 Inlet Filter Differential Pressure Transmitter	NOTE 2			13434	2.1	27-I-02	Provided by Blower System Supplier - Note 2
27-TT-E42	Blower 4 Inlet Temperature Transmitter	NOTE 2			13435	2.1	27-I-02	Provided by Blower System Supplier - Note 2
27-PSH-E42	Blower 4 Inlet High Pressure Switch	NOTE 2			13434	2.3	27-I-02	Provided by Blower System Supplier - Note 2
27-PDT-E45	Blower 4 Differential Pressure Transmitter	NOTE 2			13434	2.1	27-I-02	Provided by Blower System Supplier - Note 2
27-TT-E47	Blower 4 Discharge Temperature Transmitter	C			13435	2.2	27-I-02	Provided by Blower System Supplier - Note 2
27-PIT-E60	Blowers Discharge Pressure Transmitter	0-20	7.5	PSI	13434	2.2	27-I-02	
34-NSH-G1	Secondary Clarifier 3 High Torque Switch	NOTE 2			11231	2.2C	34-I-01	Provided by Clarifier Supplier
34-NSHH-G1	Secondary Clarifier 3 High High Torque Switch	NOTE 2			11231	2.2C	34-I-01	Provided by Clarifier Supplier
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36-FSL-H2	RAS Pump 5 Utility Water Low Flow Switch		0.75	GPM	13432	2.4	36-I-01	
36-TSH-H2	RAS Pump 5 High Temperature Switch				16220	2.7	36-I-01	Provided by Pump Motor Supplier
36-FSL-H3	RAS Pump 6 Utility Water Low Flow Switch		0.75	GPM	13432	2.4	36-I-01	
36-TSH-H3	RAS Pump 6 High Temperature Switch				16220	2.7	36-I-01	Provided by Pump Motor Supplier
36-FE/FIT-H4	RAS Pump Station Inlet Flow Sensor/Transmitter	350 - 2,800		GPM	13432	2.1	36-I-01	
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36-TSH-H5	Scum Pit Mixing Blower 2 High Temperature Switch				16220	2.7	36-I-02	Provided by Pump Motor Supplier
36-LSHH-H6	Scum Pit High High Level Switch		61.96	Feet	13433	2.5	36-I-02	
36-LSH-H6	Scum Pit High Level Switch		60.96	Feet	13433	2.5	36-I-02	
36-LSL-H6	Scum Pit Low Level Switch		50.96	Feet	13433	2.5	36-I-02	
36-LSLL-H6	Scum Pit Low Low Level Switch		47.96	Feet	13433	2.5	36-I-02	
36-FSL-H7	Secondary Scum Pump 3 Utility Water Low Flow Switch		1	GPH	13432	2.4	36-I-02	
36-TSH-H7	Secondary Scum Pump 3 High Temperature Switch				16220	2.7	36-I-02	Provided by Pump Motor Supplier
36-PSH-H7	Secondary Scum Pump 3 Effluent High Pressure Switch		25	PSI	13434	2.3	36-I-02	
36-FSL-H8	Secondary Scum Pump 4 Utility Water Low Flow Switch		1	GPH	13432	2.4	36-I-02	
36-TSH-H8	Secondary Scum Pump 4 High Temperature Switch				16220	2.7	36-I-02	Provided by Pump Motor Supplier
36-PSH-H8	Secondary Scum Pump 4 Effluent High Pressure Switch		25	PSI	13434	2.3	36-I-02	
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36-LSHH-H11	RAS Pump Station Sump High High Level Switch		43.96	Feet	13433	2.5	36-I-03	
36-LSH-H11	RAS Pump Station Sump High Level Switch		42.96	Feet	13433	2.5	36-I-03	
36-LSL-H11	RAS Pump Station Sump Low Level Switch		38.46	Feet	13433	2.5	36-I-03	
36-LSLL-H11	RAS Pump Station Sump Low Low Level Switch		37.96	Feet	13433	2.5	36-I-03	
36-MSH-H12	RAS Pump Station Sump Pump 3 High Moisture Switch				11148	2.5D	36-I-03	Provided by Sump Pump Package Supplier
36-TSH-H12	RAS Pump Station Sump Pump 3 High Temperature Switch				11148	2.5D	36-I-03	Provided by Sump Pump Package Supplier
36-MSH-H13	RAS Pump Station Sump Pump 4 High Moisture Switch				11148	2.5D	36-I-03	Provided by Sump Pump Package Supplier
36-TSH-H13	RAS Pump Station Sump Pump 4 High Temperature Switch				11148	2.5D	36-I-03	Provided by Sump Pump Package Supplier
50-AE/AIT-J12-1	Ammonia Analyzer - GSE Type	.05 - 20		mg/L	13431	2.5	50-I-1	
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51-FE/FIT-N1	WAS Storage Influent Flow Sensor/Transmitter	0 - 500		GPM	13432	2.1	51-I-01	
51-AE/AIT-N1	WAS Storage Influent Suspended Solids Analyzer	0 - 6,000		mg/L	13431	2.4	51-I-01	
51-TSH-N5	WAS Storage Mixing Blower 1 High Temperature Switch				16220	2.7	51-I-01	Provided by Pump Motor Supplier
51-PSH-N5	WAS Storage Mixing Blower 1 High Pressure Switch				13434	2.3	51-I-01	
51-TSH-N6	WAS Storage Mixing Blower 2 High Temperature Switch				16220	2.7	51-I-01	Provided by Pump Motor Supplier
51-PSH-N6	WAS Storage Mixing Blower 2 High Pressure Switch				13434	2.3	51-I-01	
51-FE/FIT-N7	WAS Storage Tank 1 Influent Air Flow Sensor/Transmitter	0 - 600		SCFM	13432	2.2	51-I-01	
51-FE/FIT-N8	WAS Storage Tank 2 Influent Air Flow Sensor/Transmitter	0 - 600		SCFM	13432	2.2	51-I-01	

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INSTRUMENT TAG NO.	DESCRIPTIONS/LOCATION	RANGE	SETPOINT NOTE 5	UNITS	SPEC. REFERENCE		P&ID REF.	REMARK
					SECTION	PARAGRAPH		
51-FE/FIT-N9	WAS Storage Tank 3 Influent Air Flow Sensor/Transmitter	0 - 600		SCFM	13432	2.2	51-I-01	
51-LE/LIT-N25	WAS Storage Tank 1 Level Sensor/Transmitter	0 - 20		Feet	13434	2.2	51-I-01	Provide diaphragm seal
51-LE/LIT-N26	WAS Storage Tank 2 Level Sensor/Transmitter	0 - 20		Feet	13434	2.2	51-I-01	Provide diaphragm seal
51-LE/LIT-N27	WAS Storage Tank 3 Level Sensor/Transmitter	0 - 20		Feet	13434	2.2	51-I-01	Provide diaphragm seal
51-AE/AIT-N28	WAS Storage Effluent Suspended Solids Analyzer	0 - 10,000		mg/L	13431	2.4	51-I-01	
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52-LE/LIT-O10-1	Dewatered Sludge Hopper Level Sensor/Transmitter 1	NOTE 2			13433	2.2	52-I-01	Provided by Dryer System Supplier - Notes 2 & 6
52-LE/LIT-O10-2	Dewatered Sludge Hopper Level Sensor/Transmitter 2	NOTE 2			13433	2.2	52-I-01	Provided by Dryer System Supplier - Notes 2 & 6
52-LSH-O10	Dewatered Sludge Hopper High Level Switch	NOTE 2			13433	2.6	52-I-01	Provided by Dryer System Supplier - Notes 2 & 6
52-LSHH-O10	Dewatered Sludge Hopper High High Level Switch	NOTE 2			13433	2.6	52-I-01	Provided by Dryer System Supplier - Notes 2 & 6
52-LSL-O10	Dewatered Sludge Hopper Low Level Switch	NOTE 2			13433	2.6	52-I-01	Provided by Dryer System Supplier - Notes 2 & 6
52-TSH-O11	Bottom Auger #1 High Temperature Switch	NOTE 2			16220	2.7	52-I-01	Provided by Dryer System Supplier - Notes 2 & 6
52-SSL-O11	Bottom Auger #1 Zero Speed Switch	NOTE 2			11600		52-I-01	Provided by Dryer System Supplier - Notes 2 & 6
52-TSH-O12	Bottom Auger #2 High Temperature Switch	NOTE 2			16220	2.7	52-I-01	Provided by Dryer System Supplier - Notes 2 & 6
52-SSL-O12	Bottom Auger #2 Zero Speed Switch	NOTE 2			11600		52-I-01	Provided by Dryer System Supplier - Notes 2 & 6
52-TSH-O15	Wet Cake Pump 1 High Temperature Switch	NOTE 2			16220	2.7	52-I-01	Provided by Dryer System Supplier - Notes 2 & 6
52-PIT-O15	Wet Cake Pump 1 Effluent Pressure Transmitter	NOTE 2			13434	2.2	52-I-01	Provided by Dryer System Supplier - Notes 2 & 6
52-PSH-O15	Wet Cake Pump 1 Effluent High Pressure Switch	NOTE 2			13434	2.3	52-I-01	Provided by Dryer System Supplier - Notes 2 & 6
52-TSH-O16	Wet Cake Pump 2 High Temperature Switch	NOTE 2			16220	2.7	52-I-01	Provided by Dryer System Supplier - Notes 2 & 6
52-PIT-O16	Wet Cake Pump 2 Effluent Pressure Transmitter	NOTE 2			13434	2.2	52-I-01	Provided by Dryer System Supplier - Notes 2 & 6
52-PSH-O16	Wet Cake Pump 2 Effluent High Pressure Switch	NOTE 2			13434	2.3	52-I-01	Provided by Dryer System Supplier - Notes 2 & 6
52-ZSH-O19-1	Wet Cake Pump 1 Pressure Relief Disk Open Position Switch	NOTE 2			11600		52-I-01	Note 6
52-ZSH-O19-2	Wet Cake Pump 2 Pressure Relief Disk Open Position Switch	NOTE 2			11600		52-I-01	Note 6
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52-TSH-O20	Paddle Dryer High Temperature Switch	NOTE 2			16220	2.7	52-I-02	Provided by Dryer System Supplier - Notes 2 & 6
52-TE/TT-O20-1	Paddle Dryer Temperature Sensor/Transmitter 1	NOTE 2			13435	2.1	52-I-02	Provided by Dryer System Supplier - Notes 2 & 6
52-TE/TT-O20-2	Paddle Dryer Temperature Sensor/Transmitter 2	NOTE 2			13435	2.1	52-I-02	Provided by Dryer System Supplier - Notes 2 & 6
52-TE/TT-O20-3	Paddle Dryer Temperature Sensor/Transmitter 3	NOTE 2			13435	2.1	52-I-02	Provided by Dryer System Supplier - Notes 2 & 6
52-TE/TT-O20-4	Paddle Dryer Temperature Sensor/Transmitter 4	NOTE 2			13435	2.1	52-I-02	Provided by Dryer System Supplier - Notes 2 & 6
52-PIT-O20	Paddle Dryer Pressure Transmitter	NOTE 2			13434	2.2	52-I-02	Provided by Dryer System Supplier - Notes 2 & 6
52-ZS-O20-1	Paddle Dryer Deflagration Panel 1 Position Switch	NOTE 2			11600		52-I-02	Provided by Dryer System Supplier - Notes 2 & 6
52-ZS-O20-2	Paddle Dryer Deflagration Panel 2 Position Switch	NOTE 2			11600		52-I-02	Provided by Dryer System Supplier - Notes 2 & 6
52-SSL-O25	Dried Solids Conveyor 1 Zero Speed Switch	NOTE 2			14552		52-I-02	Provided by Dryer System Supplier - Notes 2 & 6
52-TSH-O25	Dried Solids Conveyor 1 High Temperature Switch	NOTE 2			16220	2.7	52-I-02	Provided by Dryer System Supplier - Notes 2 & 6
52-TE/TT-O26	Dried Solids Discharge Rotary Valve Temperature Sensor/Transmitter	NOTE 2			13435	2.1	52-I-02	Provided by Dryer System Supplier - Notes 2 & 6
52-LSH-O26	Dried Solids Discharge Rotary Valve High Level Switch	NOTE 2			11600		52-I-02	Provided by Dryer System Supplier - Notes 2 & 6
52-SSL-O26	Dried Solids Discharge Rotary Valve Zero Speed Switch	NOTE 2			11600		52-I-02	Provided by Dryer System Supplier - Notes 2 & 6
52-TSH-O26	Dried Solids Discharge Rotary Valve High Temperature Switch	NOTE 2			11600		52-I-02	Provided by Dryer System Supplier - Notes 2 & 6
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52-SSL-O31	Dried Solids Conveyor 2 Zero Speed Switch				14552		52-I-03	Provided by Dryer System Supplier - Notes 2 & 6
52-TSH-O31	Dried Solids Conveyor 2 High Temperature Switch				16220	2.7	52-I-03	Provided by Dryer System Supplier - Notes 2 & 6
52-SSL-O33	Dried Solids Conveyor 3 Zero Speed Switch				14552		52-I-03	Provided by Dryer System Supplier - Notes 2 & 6
52-TSH-O33	Dried Solids Conveyor 3 High Temperature Switch				16220	2.7	52-I-03	Provided by Dryer System Supplier - Notes 2 & 6
52-TIT-O33	Dried Solids Conveyor 3 Temperature Transmitter				13435	2.1	52-I-03	Provided by Dryer System Supplier - Notes 2 & 6
52-FE/FIT-O34	Dried Solids Conveyor 2 Drain Flow Sensor/Transmitter				13432	2.1	52-I-03	Provided by Dryer System Supplier - Notes 2 & 6
52-TSH-O35	Dried Solids Screen High Temperature Switch				16220	2.7	52-I-03	Provided by Dryer System Supplier - Notes 2 & 6
52-ZSH-O35	Dried Solids Screen Open Position Switch				14552		52-I-03	Provided by Dryer System Supplier - Notes 2 & 6
52-TSH-O37	Dried Solids Return Conveyor High Temperature Switch				16220	2.7	52-I-03	Provided by Dryer System Supplier - Notes 2 & 6
52-SSL-O37	Dried Solids Return Conveyor Zero Speed Switch				14552		52-I-03	Provided by Dryer System Supplier - Notes 2 & 6
52-TSH-O39	Dried Solids Return Rotary Valve High Temperature Switch				14552		52-I-03	Provided by Dryer System Supplier - Notes 2 & 6
52-SSL-O39	Dried Solids Return Rotary Valve Zero Speed Switch				14552		52-I-03	Provided by Dryer System Supplier - Notes 2 & 6
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52-SSL-O40	Dried Solids Conveyor 4 Zero Speed Switch				14552		52-I-04	Provided by Dryer System Supplier - Notes 2 & 6
52-TSH-O40	Dried Solids Conveyor 4 High Temperature Switch				16220	2.7	52-I-04	Provided by Dryer System Supplier - Notes 2 & 6
52-TSH-O42	Dried Solids Loadout Conveyor High Temperature Switch				16220	2.7	52-I-04	Provided by Dryer System Supplier - Notes 2 & 6

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INSTRUMENT TAG NO.	DESCRIPTIONS/LOCATION	RANGE	SETPOINT NOTE 5	UNITS	SPEC. REFERENCE		P&ID REF.	REMARK
					SECTION	PARAGRAPH		
52-FSL-O51	Dryer Off-Gas Condensor Utility Water Low Flow Switch				13432	2.4	52-I-05	Provided by Dryer System Supplier - Notes 2 & 6
52-TE/TIT-O51	Dryer Off-Gas Condensor Inlet Temperature Sensor/Trasmitter				13435	2.1	52-I-05	Provided by Dryer System Supplier - Notes 2 & 6
52-PDIT-O55	Dryer Off-Gas Condensor Differential Pressure Indicating Transmitter				13434	2.1	52-I-05	Provided by Dryer System Supplier - Notes 2 & 6
52-LSH-O55	Dryer Off-Gas Condensor High Level Switch				13433	2.4	52-I-05	Provided by Dryer System Supplier - Notes 2 & 6
52-TIT-O56	Dryer Off-Gas Condensor Effluent Temperature Indicator Transmitter				13435	2.1	52-I-05	Provided by Dryer System Supplier - Notes 2 & 6
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52-TIT-O61	Thermal Fluid Return Temperature Indicating Transmitter				13435	2.1	52-I-06	Provided by Dryer System Supplier - Notes 2 & 6
52-LSL-O63	Thermal Fluid Expansion Tank Low Level Switch				13433	2.4	52-I-06	Provided by Dryer System Supplier - Notes 2 & 6
52-PSL-O63	Thermal Fluid Expansion Tank Low Pressure Switch				13434	2.3	52-I-06	Provided by Dryer System Supplier - Notes 2 & 6
52-LSH-O63	Thermal Fluid Expansion Tank Level Switch High				13433	2.4	52-I-06	Provided by Dryer System Supplier - Notes 2 & 6
52-LSL-O65	Thermal Fluid Heater Low Level Switch				13433	2.4	52-I-06	Provided by Dryer System Supplier - Notes 2 & 6
52-TSH-O65	Thermal Fluid Heater High Temperature Switch				13435	2.3	52-I-06	Provided by Dryer System Supplier - Notes 2 & 6
52-TSH-O66	Thermal Fluid Pump High Temperature Switch				13435	2.3	52-I-06	Provided by Dryer System Supplier - Notes 2 & 6
52-FE/FIT-O69	Thermal Fluid Heater Natural Gas Flow Sensor/Transmitter				11600		52-I-06	Provided by Dryer System Supplier - Notes 2 & 6
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52-PSL-O73	Compressed Air Receiver Effluent Low Pressure Switch				13434	2.3	52-I-07	Provided by Dryer System Supplier - Notes 3 & 6
52-FE/FIT-O78	Plant Utility Water Flow Sensor/Trasmitter				13432	2.1	51-I-07	Provided by Dryer System Supplier - Notes 3 & 6
52-PSL-O79	Plant Utility Water Low Pressure Switch				13434	2.3	52-I-07	Provided by Dryer System Supplier - Notes 3 & 6
52-PDIT-O80	Dust Control Scrubber Differential Pressure Indicating Transmitter				13434	2.1	52-I-08	Provided by Dryer System Supplier - Notes 3 & 6
52-FSL-O82	Dust Control Scrubber Influent Low Flow Switch				13432	2.4	52-I-08	Provided by Dryer System Supplier - Notes 2 & 6
52-PSL-O82	Dust Control Scrubber Influent Low Pressure Switch				13434	2.3	52-I-08	Provided by Dryer System Supplier - Notes 2 & 6
52-LSH-O82	Dust Control Scrubber High Level Switch				13433	2.4	52-I-08	Provided by Dryer System Supplier - Notes 2 & 6
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60-AE/AIT-K4-2	Chlorine Contact Basins Effluent Free Chlorine Analyzer	0-20	1.5	mg/L	13431	2.3	60-I-01	
60-AE/AIT-K4-3	Chlorine Contact Basins 2A/2B Free Chlorine Analyzer	0-20	1.5	mg/L	13431	2.3	60-I-01	
60-AE/AIT-K10	Chlorine Contact Basins Influent Free Chlorine Analyzer	0-20	5	mg/L	13431	2.3	60-I-01	
60-FSH-K10	Chlorine Contact Basins Influent Sample Effluent High Flow Switch	0-15	7	GPH	13432	2.4	60-I-01	
60-FSH-K21	Chlorine Contact Basin Effluent Sample Pump High Flow Switch	0-15	7	GPH	13432	2.4	60-I-01	
60-FSH-K22	Chlorine Contact Basin 2B Effluent Sample Pump High Flow Switch	0-15	7	GPH	13432	2.4	60-I-01	
60-FSH-K23	Chlorine Contact Basin 2A Effluent Sample Pump High Flow Switch	0-15	7	GPH	13432	2.4	60-I-01	
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61-TSH-I3	Filter Feed Pump 3 High Temperature Switch				16220	2.7	61-I-01	Provided by Pump Motor Supplier
61-MSH-I3	Filter Feed Pump 3 High Moisture Switch				16220	2.7	61-I-01	Provided by Pump Motor Supplier
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NOTES

1. **NOT ALL DEVICES SHOWN ON THE P&ID ARE INCLUDED ON THIS LIST: HANDSWITCHES, INTERNAL PANEL DEVICES, PACKAGED EQUIPMENT, AND OTHER ITEMS ARE NOT SHOWN.**
2. **FINAL SETPOINTS AND SETTING RANGES TO BE PROVIDED BY THE INDICATED PACKAGED SYSTEM SUPPLIER.**
3. **MULTI-FUNCTION INSTRUMENTS MAY BE LISTED FOR EACH SEPARATE OUTPUT AND/OR SENSOR REQUIRED. REFERENCE P&ID DRAWINGS FOR CLARIFICATION OF THE SIGNALS REQUIRED FROM EACH MULTI-FUNCTION INSTRUMENT.**
4. **ONLY ACTIVE POWERED DEVICES ARE LISTED IN THIS INDEX. GAGES, SITE GLASSES, THERMOMETERS, AND OTHER PASSIVE DEVICES SHALL BE PROVIDED AS SHOWN ON THE P&IDS**
5. **WHERE RANGES OR SETPOINTS ARE NOT PROVIDED, FIELD COORDINATE FINAL SETPOINTS WITH THE ENGINEER DURING COMMISSIONING**
6. **WORK IS INCLUDED AS PART OF SCHEDULES C, D AND E AND SHALL NOT BE PERFORMED IF THOSE SCHEDULES ARE NOT SELECTED. REFER TO SPECIFICATION SECTION 01025 – MEASUREMENT AND PAYMENT FOR ADDITIONAL DETAIL ON BID SCHEDULES.**

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SECTION 13431 – INSTRUMENTATION AND CONTROLS - ANALYTICAL DEVICES

PART 1 GENERAL

1.1 SCOPE OF WORK

A. This section covers the furnishing, installation, and services for the process analyzer instrumentation as shown on the Contract Documents.

1.2 RELATED WORK

A. As specified in Section 13400.

1.3 SUBMITTALS

A. As specified in Section 13400.

1.4 MAINTENANCE

A. Spares:

1. Furnish additional accessories per manufacturer's requirements including spare lamps, fuses, gaskets, seals, connectors, cables, reagent or chemical vials, light shields, desiccant cartridges, and standardized calibration references as applicable and as recommended for the unit furnished.

B. Accessories

1. All mounting hardware required for pipe stand, surface, or other mounting shall be provided.

2. Each instrument shall be provided with a manufacturer installed stainless steel tag identifying the instrument tag number as shown on the Drawings, if applicable. Provide per Section 13400.

3. One year supply of consumable chemicals and reagents for analyzers and sensors for all instruments requiring such consumables for operations.

4. One year supply of consumables for calibration for all instruments requiring consumables for calibration.

C. Provide a minimum of 8-hour startup and training services by a factory-trained technician, for each analyzer type provided.

PART 2 PRODUCTS

2.1 DISSOLVED OXYGEN ANALYZER

A. Type:

1. Luminescent sensor type.

2. Intelligent indicating converter compatible with sensor furnished.

B. Function/Performance:

1. Accuracy: Plus/minus 0.1 ppm below 5 ppm and plus/minus 0.2 ppm above 5 ppm.

2. Measuring Range: 0 to 20 ppm.

3. Operating Temperature: 0 to 50 ºC.

4. Resolution: 0.01 ppm

5. Temperature Sensor: PT100 integrated, external sensor.

6. Sensor cap: Sensor cap shall have a minimum service period of two years between cap replacement.

C. Digital Converter

1. Output: 4-20 mA with HART protocol.

2. Converter Output: Two 4-20 mA outputs with HART protocol and two alarm contact outputs rated 5A at 230VAC, adjustable over the full instrument range. A third contact output for instrument trouble shall be provided.

3. Converter enclosure shall be NEMA 4X (IP67); suitable for surface or pipe stand mounting. Provide manufacturer's standard weather protection shield and sunscreen.

4. 120VAC power supply.

5. Display:

   a. Digital indicator displaying concentration in ppm and temperature of the medium.

   b. On screen instructions and display of self-diagnostics.

   c. Monitor and display the remaining life of the sensor and other maintenance tasks.

D. Physical:

1. The sensor shall be made of polybutyl methacrolate or similar material suitable for continuous operation in highly corrosive environments.

2. The sensor shall be installed in a self-cleaning polystyrene ball float and shall not require water cleaning or chemical cleaning systems to achieve maintenance free operation for a period of 2 to 3 months when installed in a typical municipal wastewater plant aeration tank.

3. The sensor assembly shall be suitable for installation on a boom attached to hand railing or other fixed support, so that the sensor assembly floats on the liquor surface.

4. Sensor assembly shall be corrosion-resistant and submersible (IP68).

5. Converter shall be suitable for surface or pipe stand mounting.

6. Converter enclosure shall be NEMA 4X (IP67).

7. 120VAC power supply.

E. Accessories:

1. Provide sufficient cable for installation between the sensor and converter. Coordinate cable length requirements based on equipment locations as indicated on the Drawings.

2. One mounting bracket per sensor for fixing the sensor assembly boom to hand railing or other fixed support.

F. Manufacturer:

1. Hach Company LDO dissolved oxygen sensor with SC 200 converter/controller no equal to match existing equipment.

2.2 AMMONIA/NITROGEN ANALYZER – ISE TYPE

A. General: Sensor/analyzer for continuous monitoring of ammonium nitrogen in one probe suitable for wastewater treatment applications.

B. Type

1. Ion-selective electrode (ISE) with differential pH electrode as the reference and potassium ISE to correct the ammonium value for the presence of potassium ions.

2. Intelligent indicating type with integral self-diagnostics.

C. Performance

1. Measurement range ammonium: 0.2 to 1000 mg/L NH_4-N

2. Accuracy: 5% of measured value ±0.2 mg/L (with standard solution)

3. Detection limit: 0.2 mg/L

4. Response time: less than 3 minutes (T90)

D. Certifications: CE approved or equivalent

E. Environmental and Operational

1. Operating temperature: -20 to 45 °C (-4 to 114 °F)

2. Sample temperature: 2 to 40 °C (35 to 104 °F)

3. Sample pH: 5 to 9 pH

4. Sensor immersion depth: 0.3 to 3.0 meters (1 to 10 feet) maximum

5. Sample pressure: 0.3 bar (4.4 psi) maximum

F. Physical

1. Digital sensor with integrated, replaceable sensor cartridge. Integrated sensor cartridge with ammonium ISE, differential pH electrode, potassium ISE and temperature sensor.

2. The sensor shall interface directly to the manufacturer's digital controller/analyzer.

3. Provide factory calibrated sensor cartridge with all electrodes individually calibrated and also calibrated to each other.

4. Sensor shall not require sample conditioning.

5. The sensor shall perform one- or two-point inline matrix corrections to adapt it to a wastewater matrix.

6. Sensor assembly shall be corrosion-resistant and submersible (IP68).

7. Probe:

   a. 316 stainless steel

   b. Corrosion resistant plastic ends

G. Digital converter

1. Output: 4-20 mA with HART protocol.

2. Converter Output: Two 4-20 mA outputs with HART protocol and two alarm contact outputs rated 5A at 230VAC, adjustable over the full instrument range. A third contact output for instrument trouble shall be provided.

3. Converter enclosure shall be NEMA 4X (IP67); suitable for surface or pipe stand mounting. Provide manufacturer's standard weather protection shield and sunscreen.

4. 120VAC power supply.

5. Display:

   a. Digital indicator displaying concentration in mg/L and temperature of the medium.

   b. On screen instructions and display of self diagnostics.

   c. Monitor and display the remaining life of the sensor and other maintenance tasks.

H. Accessories

1. Provide sufficient cable for installation between the sensor and digital converter. Coordinate cable length requirements based on equipment locations as indicated on the Drawings. Provide cable length sufficient for the primary or alternative sensor locations whichever is greater.

2. One mounting kit per sensor for fixing the sensor assembly hand railing or other fixed support as shown on the Drawings.

I. Manufacturer

1. Hach Company, AISE sc Ammonium Sensor, with SC 200 converter/controller

2. Approved Equal

2.3 CHLORINE RESIDUAL ANALYZER

A. Type:

1. Microprocessor based electronic transmitter/converter with a flow through sample cell.

2. Measures free or total chlorine. Analyzer to be configured for free or total chlorine as indicated on the Drawings or the Instrument Device Schedule.

3. Utilizes colorimetric chemistry.

B. Function/Performance:

1. Range: 0-10 ppm for either free or total Chlorine.

2. Environmental Conditions: The instrument shall operate over an ambient temperature range of 0-40 ºC.

3. Accuracy: plus/minus 5 percent of reading, or plus/minus 0.03 ppm, whichever is greater.

4. Resolution: 0.01 ppm.

5. Output: Isolated 4-20 mA output and 3 alarm contacts rated 5 A at 230 VAC, adjustable to trip at any point in the instrument range.

6. Display: Dot matrix or LCD type displaying chlorine residual in ppm.

7. Temperature Compensation: Compensated for sample temperatures over the temperature range of the instrument.

8. Diagnostics: On screen instructions and self diagnostics.

9. Minimum detection limit: 0.03 ppm.

10. Repeatability: 0.05 ppm.

C. Physical:

1. Analyzers shall be suitable for wall mounting.

2. A/C power will be as specified in Section 13400.

3. Enclosure shall be NEMA 12, IP-62 rated.

D. Accessories Required:

1. Provide one year supply of reagent.

2. Provide one year supply of maintenance kits including tubing, adapters, and parts as recommended by the manufacturer.

E. Manufacturer(s):

1. Hach CL17

2. Approved equal

2.4 SUSPENDED SOLIDS TRANSMITTER

A. General: The suspended solids transmitter shall consist of an indicating transmitter, suspended solids sensor, mounting hardware and interconnecting cables.

B. Transmitter

1. Each transmitter shall be microprocessor-controlled with digital readout and 4-20 mA DC isolated output proportional to suspended solids concentration.

2. Digital readouts shall be visible in darkened areas by means of illuminated characters or back lit displays.

3. The display shall be able to indicate suspended solids concentration, alarm set points, and status messages.

4. Each transmitter shall be housed in a NEMA Type 4X enclosure, and shall be suitable for either surface or panel mounting. The enclosure shall also provide EMI/RFI shielding.

5. Power requirements shall be 115 Vac ±10 percent, 60 Hz.

C. Sensors

1. Sensors shall be suitable for immersion in open tank applications.

2. Sensors shall be stainless steel body with silicon wiper.

3. All fittings and mounting components required to install the sensor shall be furnished.

4. Interconnecting cable shall be supplied and shall be of suitable length for proper installation and servicing of the probe assembly.

5. The instrument shall be equipped with the ability for calibration.

6. Units of measure shall be user selectable.

7. Accuracy shall be <1 percent of measuring range.

8. Repeatability of the instrument shall be < 3 percent of reading.

9. Response time shall be adjustable.

D. Accessories Required:

1. Provide a one year supply of calibration standards.

2. Provide a package of five wiper blades.

3. One mounting bracket per sensor for fixing the sensor assembly boom to hand railing or other fixed support.

E. Manufacturers:

1. Hach SOLITAX sc

2. Approved equal.

2.5 AMMONIA/NITROGEN ANALYZER – GSE TYPE

A. General: Sensor/analyzer for continuous monitoring of ammonium in water.

B. Type

1. Gas sensitive electrode (GSE) that uses liquid to gas- phase conversion.

2. Continuous, filtered sample from peristaltic pump. Sample shall be mixed with sodium hydroxide converting all ammonium to ammonia gas, expelled from the sample, re-dissolved in an indicator reagent, and changing the pH to produce a color change. A colorimeter measures the color change of the solution and the reading is converted to ammonia concentration.

3. Intelligent indicating type with integral self-diagnostics.

C. Performance

1. Measurement range ammonia: 0.05 to 20 mg/L NH_4-N

2. Accuracy: 3% of measured value ±0.05 mg/L (with standard solution)

3. Lower detection limit: 0.05 mg/L NH_4-N

4. Reproducibility: 2% ±0.05 mg/L

5. Response time: less than 5 minutes including sample preparation (T90)

6. Measurement interval: 5 to 120 minutes, adjustable

D. Certifications:

1. CE approved or equivalent

2. Listed to UL and CSA safety standards by TUV.

E. Environmental and Operational

1. Operating temperature: -20 to 45 °C (-4 to 114 °F)

2. Sample temperature: 4 to 40 °C (39 to 104 °F)

3. Sample pH: 5 to 9 pH

4. Operating Humidity: 95% relative humidity, non-condensing

F. Physical

1. Analyzer with integral gas sensitive electrode and colorimeter

2. 120VAC powered

3. Analyzer with self-calibration, self-cleaning, and integrated self-diagnostic routines

4. The analyzer shall interface directly to the manufacturer's digital controller.

5. Analyzer housing shall be UV Resistant, IP55, with provision for pad locking

G. Sample Pump and Filtration Module

A. Provide peristaltic sample pump with membrane plate filters to remove suspended solids from the sample to be analyzed. Provide sample pump controller, sample pump, and submersible membrane filter modules. Provide sample hose sufficient to connect sample pump and filtration module to analyzer.

B. Performance Requirements

1. Flow: 900 mL/h (nominal) or as required by the analyzer

2. Provide sample pump suitable for serving up to three process analyzers

C. Physical

1. Stand-alone sample pump system

2. 120VAC

3. Provide minimum of two programmable output relays for remote status monitoring or alarms

4. Stainless steel sample pump controller housing suitable for outdoor installation.

5. Stainless steel sample pump filtration module fully submersible

6. Delivery hoses suitable for outdoor installation, PVC, minimum length 5 meters (16 feet) or as required by the installation arrangement or as shown on the Drawings.

7. Sample delivery hoses: PVC, length as required by the installation arrangement or as shown on the Drawings

H. Digital converter

1. Output: 4-20 mA with HART protocol.

2. Converter Output: Two 4-20 mA outputs with HART protocol and two alarm contact outputs rated 5A at 230VAC, adjustable over the full instrument range. A third contact output for instrument trouble shall be provided.

3. Converter enclosure shall be NEMA 4X (IP67); suitable for surface or pipe stand mounting. Provide manufacturer's standard weather protection shield and sunscreen.

4. 120VAC power supply.

5. Display:

   a. Digital indicator displaying concentration in mg/L and temperature of the medium.

   b. On screen instructions and display of self-diagnostics.

   c. Monitor and display the remaining life of the sensor and other maintenance tasks.

I. Accessories

1. Provide sufficient cable for installation between the analyzer and digital converter. Coordinate cable length requirements based on equipment locations as indicated on the Drawings. Provide cable length sufficient for the primary or alternative sensor locations whichever is greater.

2. Provide sufficient supply and sample hose lengths for connecting sample pump/filter to analyzer

3. Mountings kit for analyzer, sample pump controller, sample pump, filtration modules, and digital converter unit. Provide mounting hardware suitable fixing analyzer components to hand railing or other fixed support as shown on the Drawings. Provide brackets for mounting filtration module submerged in the splitter box as shown on the Mechanical drawings.

4. Spare parts

   a. Three sample pump stirrer arms

   b. Three sets of sample pump valves

   c. Three sets of sample pump cylinder and piston

d. Three sets of filter elements

e. Provide one-year supply of analyzer reagents or other required chemicals

J. Manufacturer

1. Hach Company, AMTAX sc Ammonium Sensor, with SC 200 converter/controller, and Filtrax sample pump

2. Approved Equal

PART 3 EXECUTION

3.1 GENERAL

A. Install in conformance with manufacturer's requirements and as specified under Section 13400.

END OF SECTION

SECTION 13432 – INSTRUMENTATION AND CONTROLS - FLOW MEASUREMENT

PART 1 GENERAL

1.1 SCOPE OF WORK

A. This section covers the furnishing, installation, and services for the flow measurement instrumentation as shown on the Contract Documents.

1.2 RELATED WORK

A. As specified in Section 13400.

1.3 SUBMITTALS

A. As specified in Section 13400.

1.4 MAINTENANCE

A. Accessories

1. All mounting hardware required for pipe stand, surface, or other mounting shall be provided.

2. Each instrument shall be provided with a manufacturer installed stainless steel tag identifying the instrument tag number as shown on the Drawings. Provide per Section 13400.

PART 2 PRODUCTS

2.1 MAGNETIC FLOWMETER

A. Flow Element

1. Type:

a. Pulsed DC type.

2. Function/Performance:

a. Operating Temperature: Process liquid temperatures of –10˚ to 70˚ C and an ambient of –10˚ to 60˚ C.

b. RFI protection: RFI protection to be provided.

c. Pressure rating: Equal to piping system where meter is installed.

d. Additional: Meter shall be capable of running empty indefinitely without damage to any component.

3. Physical:

a. Metering Tube: 304 stainless steel or equivalent.

b. Flanges: ANSI 150 lb. or DIN PN 16 carbon steel, as required by the piping system, unless otherwise indicated.

c. Liner: Polyurethane unless otherwise indicated on the Drawings or in the Instrument Device Schedule.

d. Electrodes: 316 stainless steel, bullet nosed or elliptical self cleaning type unless otherwise noted.

e. Housing: Meters below grade shall be suitable for submergence for up to 48 hours to a depth of 30 ft (9m). Meters above grade shall be NEMA 4X (IP65). Where hazardous areas are indicated on the Drawings, the equipment shall be rated for that area.

f. Finish: All external surfaces shall have a chemical and corrosion resistant finish.

4. Accessories/Documentation Required:

a. Factory calibration: All meters shall be factory calibrated. A copy of the report shall be included in the O&M manual.

b. Grounding: Meter shall be grounded in accordance with the manufacturer's recommendation. Provide ground ring, ground wires, gaskets, etc., as required. All materials shall be suitable for the liquid being measured.

c. Signal cable for installation between the flowtube and the transmitter. Length shall be as required by installation indicated on the Drawings.

5. Manufacturer(s):

a. ABB Instruments MagMaster; no equal to match existing meters at the facility.

B. Flow Converter/Transmitter

1. Type:

a. Micro processor based, intelligent transmitter compatible with flowtube provided.

b. The transmitter shall be mounted integrally on the flow tube, or remotely mounted on an instrument stand, wall, or control panel as shown on the Drawings.

2. Functional/Performance:

a. Accuracy (including flowtube): Plus/minus 0.5 percent of flowrate.

b. Operating Temperature: -10 to 50˚ C.

c. Output: Isolated 4-20 mA with HART protocol. Current output adjustable over the full range of the instrument.

d. Diagnostics: Self diagnostics with on screen display of faults.

e. Display: Digital indicator displaying flow in engineering units indicated in the Instrument Device Schedule.

f. Totalizer: A fully configurable totalizer integral to the transmitter. Totalized flow shall be displayed.

g. Empty Tube Zero: The transmitter shall include a feature that will lock the output at zero when no flow is detected. The empty tube zero feature shall be enabled automatically when the transmitter detects no flow or manually through a contact input.

3. Physical:

a. Transmitter shall be suitable for surface or instrument stand mounting.

b. Enclosure shall be NEMA 4X (IP65).

c. 120VAC input power or as shown on the Instrument List.

4. Accessories/ Required:

a. Keypad where required for transmitter configuration.

b. If hand-held programmers, special tools, software or cables are required for configuration and setup, the contractor shall provide one set of configuration equipment, plus and additional set of configuration equipment for every five flow meters provided on this project..

5. Manufacturer(s):

a. ABB Instruments MagMaster; no equal to match existing meters at the facility.

2.2 AIR FLOW METERS

A. General: Provide thermal mass flow, dispersion type sir flow meter suitable for the operating ranges as shown on the Instrument index

B. Flow Sensors

1. Provide air flow meter, thermal mass flow type with insertion probe into the air stream, suitable for high temperature discharge and corrosion resistant.

2. Provide flow transmitter integral with the sensor probe, internal calibration, and with automatic temperature compensation.

3. Provide transmitter with NEMA 4X enclosure, 120VAC input power. Maximum temperature rating up to 250°F.

4. Provide self-diagnostic circuitry that automatically detects bad data from sensor with indication of reading error.

5. Provide a digital display and outputs that indicates air flow rate in scfm, diagnostics, and calibration readings.

6. 4-20 mA DC output signal shall be directly proportional to the measured air flow rate in scfm. Provide HART interface on the 4-20mA output signal.

7. Accessories

   a. When remote mounted sensor is shown, provide sufficient cable for installation between the sensor and converter. Coordinate cable length requirements based on equipment locations as indicated on the Drawings.

   b. Provide all hardware and accessories for mounting the probe in the air piping, and the transmitter on the handrail or stanchion mounted as shown on the Drawings.

8. Manufacturers:

   a. Endress & Hauser, Proline t-mass 65I

   b. FCI

   c. Approved Equal

2.3 THERMAL DISPERSION FLOW SWITCH

A. Type:

1. Thermal dispersion flow switch with integral electronics enclosure.

2. In line with flowbody for line sizes 1-inch and smaller; insertion type for all other line sizes unless noted otherwise on the Drawings or Instrument Schedule.

B. Function/Performance

1. Range: 1 to 125 ft/s (0.3 to 38 m/s) in air.

2. Process Operating Temperature: -40 to 170° C.

3. Operating Temperature for Electronics: -40 to 60° C.

4. Accuracy: Plus/minus 5 percent of reading.

5. Repeatability: Plus/minus 0.5% of reading.

6. Output: DPDT contacts rated 6 A at 120 VAC adjustable over the range of the instrument.

C. Physical:

1. Wetted parts to be 316 stainless steel.

2. Electronics head to be NEMA 4X (IP65) for non-hazardous process gases and explosion proof approved for Class 1, Division 1, Groups C and D (EEx d IIC) for hazardous process gases or where located in a hazardous area.

3. A/C power will be as specified in Section 13400.

D. Accessories Required:

1. For insertion type flow elements a hot tap assembly including a ball valve and packing gland that will allow removal of the sensor without shutdown of the process, shall be provided. The hot tap assembly shall be installed in a welded fitting on the pipe.

E. Manufacturers:

1. Fluid Components International FLT93-F.

2. Approved equal.

2.4 VANE ACTUATED FLOW SWITCH

A. Type:

1. Vane or disc actuated flow switch.

2. Switch magnetically linked to vane or disc actuated mechanism.

B. Function/Performance:

1. Output: Form 2C (DPDT) snap action, hermetically sealed switch, rated for 10 amps, 125/250 volts AC.

C. Physical:

1. Switches for pipe sizes of 3/4 to 1-1/2 inches (19 to 40 mm) shall be provided with a flowbody. Switches for pipe sizes greater than 1-1/2 inches (40 mm) shall be for installation directly in the field piping.

2. Flow body and all wetted parts shall be 316 stainless steel.

3. Switch housing shall be NEMA 4X (IP65) and where installed in hazardous areas, shall be approved for Class I, Division 1, Groups C and D (EEx d IIC T6).

D. Manufacturer(s):

1. Magnetrol F50 and F10

2. Dwyer.

3. Approved equal.

PART 3 EXECUTION

3.1 GENERAL

A. Install in conformance with manufacturer's requirements and as specified under Section 13400.

END OF SECTION

SECTION 13433 – INSTRUMENTATION AND CONTROLS - LEVEL MEASUREMENT

PART 1 GENERAL

1.1 SCOPE OF WORK

A. This section covers the furnishing, installation, and services for the level measurement instrumentation as shown on the Contract Documents.

1.2 RELATED WORK

A. As specified in Section 13400.

B. Pressure sensing absolute or differential level devices are specified in Section 13434

1.3 SUBMITTALS

A. As specified in Section 13400.

1.4 MAINTENANCE

A. Accessories

1. All mounting hardware required for pipe stand, surface, or other mounting shall be provided.

2. Each instrument shall be provided with a manufacturer installed stainless steel tag identifying the instrument tag number as shown on the Drawings. Provide per Section 13400.

PART 2 PRODUCTS

2.1 ULTRASONIC LEVEL

A. Transducer

1. Type:

a. Non-contact, ultrasonic level transducer.

2. Function/Performance:

a. Measuring Ranger: Transducer range shall be suitable for the installation indicated on the Drawings, up to 50 ft (15m).

b. Temperature Range: -30 to 70° C.

c. Relative humidity: 0 to 100 percent.

d. Temperature Compensation: Transducers shall be provided with integral temperature sensors for temperature compensation.

3. Physical:

   a. Transducers shall be potted/encapsulated in a Kynar or other chemical and corrosion resistant housing. Where indicated on the Drawings, transducers shall be approved for installation in Class I, Division 1, Groups C and D (Zone 0) environments.

   b. The surface of transducers shall be Teflon coated where mounted on chemical tanks and exposed to vapors in the tanks that are not compatible with the transducer material.

   c. Transducers shall be capable of being completely submersed without damage.

   d. Transducers shall be suitable for surface, pipe, or flange mounting as indicated on the Drawings or Instrument Device Schedule. Appropriate mounting hardwired shall be provided. Flanges shall be 6 inch (150 mm) and resistant to attack by the medium being metered, or where required, shall be protected by corrosion resistant coatings and facings.

4. Options/Accessories Required:

   a. Transducers located in areas where freezing condensation may occur shall be provided with special heaters or other type of transducer protection designed to prevent sensor icing.

   b. Signal cable as recommended by the manufacturer, for installation between the transducer(s) and the transmitter. Length, up to 1000 feet (300 m), shall be as required by installation indicated on the Drawings.

5. Manufacturer(s):

   a. Siemens Model XPS

   b. Rosemount 3100 Series

   c. Approved equal.

B. Transmitter/Converter

1. Type:

   a. Microprocessor based compatible with the transducer(s) provided.

2. Functional/Performance:

   a. Resolution (including transducer): Plus/minus 0.1% of range or 0.08 inches (2 mm), whichever is greater.

   b. Accuracy (including transducer): Plus/minus 0.25% of range or 0.24 inches (6 mm).

   c. Range: As required by the installation indicated on the drawings.

d. Temperature Range: -20 to 50° C.

e. Output: One isolated 4-20 mA output with HART communication and 4 alarm contacts adjustable to trip at any point in the instrument range. Output contacts shall be rated 5 A at 230 VAC.

f. Temperature Compensation: Compensation over the temperature range of the sensor.

g. Display: Digital indicator displaying level/differential level or volume in engineering units or percent as indicated on the Drawings or in the Instrument Device Schedule.

h. Diagnostics: On screen instructions and display of self diagnostics.

i. Loss of Signal: Transmitter shall ignore momentary loss-of-echo signals and shall indicate loss of echo on the transmitter unit.

j. Configuration Protection: Programmable parameters shall be protected using E2PROM. Battery backup protection is not acceptable

3. Physical:

a. Transmitter shall be suitable for surface or pipe stand mounting.

b. Enclosure shall be NEMA 4X (IP65).

c. 120VAC input power or as shown on the Instrument List.

4. Accessories Required:

a. Handheld programmer where required for configuration and calibration of the instrument.

5. Manufacturer(s):

a. Siemens Model HydroRanger 200.

b. Rosemount 3490 Series

c. Approved equal.

2.2 RADAR LEVEL METER

A. Type:

1. Non-contact, microwave type level meter.

B. Function/Performance:

1. Measuring Range: Range as indicated in the Instrument Device Schedule, up to 50 ft (15m).

2. Accuracy: Plus/minus 0.3 percent or plus/minus 1.2 inches (30mm) whichever is greater.

3. Operating Temperature: -40˚ to 60° C.

4. Output: Isolated 4-20 mA output with HART communication.

5. Display: Digital indicator displaying level or volume in engineering units or percent, as indicated on the Drawings or in the Instrument Device Schedule.

6. Diagnostics: On screen instructions and display of self diagnostics.

C. Physical:

1. Instrument shall be provided with a stainless steel mounting hardware as specified or as shown on the Drawings.

2. Housing shall be NEMA 4X (IP66). Where the instrument is installed in a hazardous area, the housing shall be explosion proof approved for Class I, Division 1, Groups C and D (EEx d IIB T4) installation. The instrument shall be certified for installation of the antenna in a Class I, Division 1, Groups C and D (Zone 0) environment.

3. Transducer cone type, size, and beam frequency shall be as recommended by the manufacturer for the specific application in which it is to be installed.

4. Unit shall be a loop powered two-wire transmitter.

D. Accessories Required:

1. Where required for calibration/programming, a hand held programmer shall be provided.

E. Manufacturer(s):

1. Siemens LR 200

2. Rosemount 5400

3. Approved Equal

2.3 WEIGHTED FLOAT TYPE LEVEL SWITCHES

A. Type:

1. Weighted switch cable assembly for suspension on its own cable without pipe support.

B. Function/Performance:

1. Temperature Rating: 0–60˚ C.

2. Contact Rating: Up to 250V AC/DC, and 8 amps AC, 5 amps DC.

3. Contact Arrangement: Form C contact that is field selectable normally open or closed.

C. Physical:

1. Contact: Hermetically sealed mechanical switch housed in a chemical-resistant polypropylene casing. No mercury allowed.

2. Flexible Support Cable: Synthetic three wire cable, minimum 19 AWG wire.

3. Specific Gravity: Suitable for to fluid being measured.

D. Options/Accessories Required:

1. Provide flexible support cable of sufficient length to ensure no splice or connection is required in the wetwell or tank.

2. Provide junction box outside the wetwell/tank for connection of cable. Refer to Section 13400 for NEMA rating and size.

3. Provide stainless steel supports/mounting accessories as required.

E. Manufacturers:

1. Flygt Model ENM-10.

2. Approved equal.

2.4 FLOAT SWITCH – FIXED MOUNT

A. Type:

1. Ball float switch.

B. Function/Performance:

1. Differential: Less than 1 inch (25 mm).

2. Output: Switch rated 20 A at 240 VAC.

C. Physical:

1. Float: Polypropylene or similar material.

2. Switch: Hermetically sealed mechanical switch housed in a chemical-resistant polypropylene casing. No mercury allowed.

3. Cable: Heavy duty, PVC jacketed, integral to float. Sufficient cable length shall be provide so that no splice is required in the wet well, reservoir, or process vessel.

D. Manufacturer(s):

1. Consolidated Electric Co. Model 9G

2. Flygt

3. Approved equal.

2.5 POINT LEVEL ELECTRODE SWITCH AND SENSING RELAYS

A. Type:

1. Conducting electrodes that actuate a solid state relay (level switch) on contact between two conducting electrodes.

2. Single point solid state plug-in relay.

B. Function/Performance

1. SPDT contacts for each level switch indicated on the Drawings. Contacts shall be rated 10 A at 240 VAC.

C. Physical

1. Electrodes shall be 316 stainless steel rigid rod type. Electrodes shall be Teflon sheathed.

2. Electrode holder shall be an epoxy coated aluminum terminal housing mounted on a 316SS 2-1/2 inch pipe flange. The flange assembly shall be rated for installation in processes up to 200 PSI.

3. Relays shall include DIN rail mounted plug in sockets with screw type terminals.

4. Contact arrangement and sensitivity shall be configured as required for the application.

D. Manufacturers

1. Gems Sensors, Warrick 3RT probes, series 3F fittings and Series 16M Relays.

2. Ametek B/W Controls.

3. Approved Equal.

2.6 VIBRATING FORK LEVEL SWTICH

A. Type:

1. Vibration “tuning fork” technology, piezo-electric crystal based. Changes in vibrating frequency occur upon immersion (high level) or exposure (low level)

B. Function/Performance

1. DPDT contacts suitable for direct load switching AC or DC.

2. Integral diagnostics for continuous checking of electronics and mechanical condition. Provide integral status LED for visual indication of device health

C. Physical

1. Wetted parts: 316 stainless steel rigid rod type. Provide extension fittings from the manufacturer to meet specified set point level as indicated on the Instrument List per Section 13430, Appendix A.

2. Stainless Steel terminal housing mounted on a 316 Stainless Steel pipe flange. The flange assembly shall be rated for installation in processes up to 150 PSI.

3. NEMA 4X rated or explosion proof where installed in hazardous areas as shown on the Drawings

4. Temperature: -40°–200° F (minimum)

5. Process connection: ¾-inch NPT unless noted otherwise

6. Electrical connection: Terminal blocks

7. Contact arrangement and sensitivity shall be configured as required for the application.

D. Manufacturers

1. Endress + Hauser, FEL54

2. Rosemount 2130

3. Approved Equal.

PART 3 EXECUTION

3.1 GENERAL

A. Install in conformance with manufacturer's requirements and as specified under Section 13400.

END OF SECTION

This page is intentionally blank.

SECTION 13434 – INSTRUMENTATION AND CONTROLS - PRESSURE MEASUREMENT

PART 1 GENERAL

1.1 SCOPE OF WORK

A. This section covers the furnishing, installation, and services for the pressure measurement instrumentation as shown on the Contract Documents.

1.2 RELATED WORK

A. Refer to Section 13400.

1.3 SUBMITTALS

A. Refer to Section 13400.

1.4 MAINTENANCE

A. Refer to Section 13400

B. Spares:

1. Two or 5% (whichever is greater) spare low pressure switches (set points less than 15 psi) of the total provided, whichever is greater.

C. Accessories

1. All mounting hardware required for pipe stand, surface, or other mounting shall be provided.

2. Each instrument shall be provided with a manufacturer installed stainless steel tag identifying the instrument tag number as shown on the Drawings. Provide per Section 13400.

3. Pressure instruments shall be provided with isolation valves, bleed valves, valve manifolds, tubing, pipe manifolds, process seals, and fittings as shown on the Drawings.

PART 2 PRODUCTS

2.1 DIFFERENTIAL PRESSURE TRANSMITTERS

A. Type:

1. Microprocessor based, intelligent type.

B. Function/Performance:

1. Range: Range of the transmitter shall be the standard range of the manufacturer closest to the differential pressure range to be metered.

2. Accuracy: 0.05 percent of span (linear output).

3. Operating Temperature: -20 to 80° C.

4. Temperature Effect: Combined temperature effects shall be less than 0.2 percent of maximum span per 28° C temperature change.

5. Static Pressure Effect: Effect on accuracy due to static pressure changes shall be negligible.

6. Output: 4-20 mA DC adjustable over the instrument range, with HART protocol. Output shall be linear for differential pressure applications. For flow metering applications the output shall be proportional to the square root of the input differential pressure.

7. Stability: 0.2 percent of upper range limit for 5 year.

8. Display: Digital indicator displaying differential pressure or flow in the engineering units indicated in the Instrument Device Schedule.

9. Diagnostics: Self diagnostics with transmitter failure driving output to above or below out of range limits.

10. Over Range Protection: Provide positive over range protection to 150% of the maximum pressure of the system being monitored by the instrument.

C. Physical:

1. Enclosure: NEMA 4X (IP66), explosion proof, approved for Class I, Division 1, Groups C and D (EEx d IIC T5).

2. Process Wetted Parts: Isolating diaphragm and other wetted metal parts shall be 316L stainless steel, unless otherwise indicated in the device schedule. Gaskets and O rings shall be Teflon.

3. Instrument flange shall include a 316 stainless steel drain/vents for each process connection.

4. Power Supply: 24 VDC loop power.

5. Sensor Fill Fluid: Silicone.

D. Accessories Required:

1. Provide span and zero adjustment at each transmitter and through the handheld programming unit.

2. For each transmitter provide five valve manifold. The manifold shall be 316 stainless steel. Manifolds may be mounted directly to the instrument or separately mounted. Manifolds shall be by the instrument manufacturer, D/A Manufacturing, or Anderson Greenwood.

3. Provide mounting accessories necessary.

E. Manufacturer(s):

1. Rosemount 3051CD

2. ABB

3. Endress & Hauser

4. Approved equal.

2.2 GAUGE PRESSURE OR PRESSURE SENSING LEVEL TRANSMITTERS

A. Type:

1. Microprocessor based, intelligent type.

B. Function/Performance:

1. Range: Range of the transmitter shall be the standard range of the manufacturer closest to the pressure range to be metered.

2. Accuracy: 0.05 percent of span.

3. Operating Temperature: -20 to 80° C.

4. Temperature Effect: Combined temperature effects shall be less than 0.2 percent of maximum span per 28° C temperature change.

5. Output: 4-20 mA DC linear with pressure or level, with HART protocol. Zero adjustable over the range of the instrument provided calibrated span is greater than the minimum calibrated span.

6. Stability: 0.2 percent of upper range limit for 1 year.

7. Display: Digital indicator displaying pressure or level in the engineering units indicated in the Instrument Device Schedule.

8. Diagnostics: Self diagnostics with transmitter failure driving output to above or below out of range limits.

9. Over Range Protection: Provide positive over range protection to 150% of the maximum pressure of the system being monitored by the instrument.

10. If required to meet the range or suppression/elevation requirements, a differential pressure transmitter shall be provided.

C. Physical:

1. Enclosure: NEMA 4X (IP66), explosion proof, approved for Class I, Division 1, Groups C and D (EEx d IIC T5).

2. Process Wetted Parts: Isolating diaphragm and other wetted metal parts shall be 316L stainless steel, unless otherwise indicated in the device schedule. Gaskets and O rings shall be Teflon.

3. Power Supply: 24 VDC loop power.

4. Sensor Fill Fluid: Silicone.

D. Accessories Required:

1. Provide span and zero adjustment at each transmitter and through the handheld programming unit.

2. For each transmitter provide a 316 stainless steel block and bleed valve. Valves may be mounted directly to the instrument or separately mounted. Valves shall be by the instrument manufacturer or by D/A Manufacturing or Anderson Greenwood.

E. Manufacturer(s):

1. Rosemount 3051CG

2. ABB

3. Endress & Hauser

4. Approved equal.

2.3 PRESSURE SWITCH

A. Type:

1. Diaphragm actuated.

B. Function/Performance:

1. Repeatability: Better than 1 percent of full scale.

2. Setpoint: Field adjustable and set between 30 and 70 percent of the adjustable range.

3. Dead Band: Fixed unless adjustable dead band requirement is noted in the Instrument Device Schedule.

4. Reset: Unit shall be of the automatic reset type unless noted otherwise in the Instrument Device Schedule.

5. Over Range Protection: Over range protection to 150% of the maximum process line pressure.

6. Output: Single pole double throw (SPDT) unless requirement for double pole double throw (DPDT) switch is shown on the instrument device schedule. Switch rating shall be 10 A at 230 VAC.

C. Physical:

1. Housing: NEMA 4X (IP65) for non hazardous areas. For installation in hazardous areas, housing shall be explosion proof approved for Class 1, Division 1, Groups C and D (EEx d IIB).

2. Switch Assemblies: Hermetically sealed switches.

3. Wetted Parts: 316L stainless steel diaphragm, viton seals, 316 stainless steel connection port.

D. Accessories/Options Required:

1. Shutoff Valve: Provide a 316 stainless steel shutoff valve. Valve shall be by D/A Manufacturing, Anderson Greenwood, or approved equal.

2. Where indicate on the instrument device schedule, provide a 316 SS snubber for pulsation dampening.

E. Manufacturer(s):

1. Static-O-Ring (SOR)

2. Ashcroft

3. Mercoid

4. Approved equal

2.4 DIFFERENTIAL PRESSURE SWITCH

A. Type:

1. Diaphragm actuated.

B. Function/Performance:

1. Setpoint: Field adjustable and set between 30 and 70 percent of the adjustable range.

2. Dead Band: Fixed deadband.

3. Over Range Protection: Over range protection to twice the maximum process line pressure.

4. Output: Dry contacts rated 10 A at 230 VAC. Single pole double throw (SPDT) unless requirement for double pole double throw (DPDT) switches is shown on the instrument device schedule.

C. Physical:

1. Housing: NEMA 4X (IP65) for non hazardous areas. For installation in hazardous areas, housing shall be explosion proof approved for Class 1, Division 1, Groups C and D (EEx d IIB T5).

2. Switching Assemblies: Hermetically sealed switches.

3. Wetted Parts: 316L stainless steel diaphragm, viton seals, 316 stainless steel connection port.

D. Accessories/Options Required:

1. For each differential pressure switch, provide a three valve manifold. The manifold shall be 316 stainless steel. Manifolds shall be D/A Manufacturing or Anderson Greenwood.

E. Manufacturer(s):

1. Static-O-Ring (SOR)

2. Ashcroft

3. Mercoid

4. Approved equal.

2.5 PROCESS INSTRUMENT SEALS

A. Provide diaphragm seals and annular seals where shown on the Drawings or where the instrument wetted parts are not chemically compatible with the process fluid being measured.

B. Provide isolation valve between seal and process to allow isolation and replacement of the seal and instrument.

C. Diaphragm Seal – Threaded

1. Type:

a. Thread attached.

b. Welded Metal Diaphragm.

2. Function/Performance:

a. Maximum Pressure: Two times the maximum process pressure.

b. Operating Temperature: -40 to 100° C.

3. Physical:

a. All 316L stainless steel construction.

b. Teflon gaskets and O rings on process connection.

c. Filling screw and bleeding connection provided.

4. Accessories Required:

a. Stainless steel armored capillary tubing as required for the installation.

5. Manufacturer(s):

a. Rosemount.

b. Ashcroft.

c. Ronningen-Petter Company

d. Approved equal

D. Annular Seal

1. Type:

a. Line mounted, between two flanges.

2. Function/Performance:

a. Pressure Limit: Correspond to flange ratings.

b. Inside diameter shall conform to the dimensions of the pipe where the seal is installed.

c. ANSI or DIN flange class shall be equivalent to the flange class of the piping where the seal is installed. Bolting dimensions shall conform to ANSI or DIN drilling specifications as required by the installation.

3. Physical:

a. Body material: Carbon steel.

b. Process connection: 1/4-inch NPT.

c. Sensing Sleeve: Buna-N.

d. Sensing Liquid: Silicone Oil.

4. Manufacturer(s):

a. Red Valve Company, Inc.

b. Ashcroft

c. Wika

d. Approved equal

PART 3 EXECUTION

3.1 GENERAL

A. Install in conformance with manufacturer's requirements and as specified under Section 13400.

END OF SECTION

This page is intentionally blank.

SECTION 13435 – INSTRUMENTATION AND CONTROLS - TEMPERATURE MEASUREMENT

PART 1 GENERAL

1.1 SCOPE OF WORK

A. This section covers the furnishing, installation, and services for temperature measurement instrumentation as shown on the Contract Documents.

1.2 RELATED WORK

A. As specified in Section 13400.

1.3 SUBMITTALS

A. As specified in Section 13400.

1.4 MAINTENANCE

A. Accessories

1. All mounting hardware required for pipe stand, surface, or other mounting shall be provided.

2. Each instrument shall be provided with a manufacturer installed stainless steel tag identifying the instrument tag number as shown on the Drawings. Provide per Section 13400.

PART 2 PRODUCTS

2.1 TEMPERATURE ELEMENT/TRANSMITTER

A. Sensor

1. Type:

a. Four wire platinum RTD.

2. Function/Performance:

a. Range: As required by the measuring range indicated in the Instrument Device Schedule.

b. Accuracy: Resistance versus temperature shall meet performance requirements of IEC 751 Class B.

c. Maximum Thermal Response Time: 5 seconds to reach 63% sensor response when tested in flowing water according to IEC 751.

d. Temperature Coefficient: 100 ohms at 0° C, with temperature coefficient of 0.00385 ohms/ohm/degree C.

e. Self Heating: Maximum self heating factor of 0.15° C/mW.

3. Physical:

a. 316 stainless steel sheath.

b. Spring loaded sensor assembly.

c. Sensor shall penetrate into the pipe where it is installed, by 1/3 to ½ of the pipe diameter.

d. Sensor shall be provided with covered connection head. Sensor and connection head shall be NEMA 4X (IP66). Where indicated on the drawings to be installed in a hazardous location, the sensor assembly shall be explosion proof approved for Class I, Division 1, Groups C and D (EEx d IIC).

4. Accessories Required:

a. Sensors shall be installed in 316L stainless steel thermowells. Thermowells shall be threaded accept for those installed in ozone system piping which shall be welded.

b. Extensions shall be provided for sensors installed in insulated pipe. Extensions shall clear the pipe insulation. Extensions shall also be provided where process temperatures are above 100° C.

5. Manufacturer(s):

a. Rosemount Series 78

b. ABB

c. Endress & Hauser

d. Approved equal

B. Transmitter:

1. Type:

a. Remotely mounted, two wire, intelligent transmitter compatible with sensor provided.

2. Function/Performance:

a. Digital Accuracy: Plus/minus 0.2° C.

b. Stability: Plus/minus 0.1 percent or 0.1° C, whichever is greater, for 24 months.

c. Operating Temperature: -40 to 85° C.

d. Output: 4-20 mA DC linear with temperature with integral HART signal

e. Display: Digital indicator displaying temperature in engineering units.

f. Diagnostics: Self diagnostics with transmitter failure driving output to above or below out of range limits.

3. Physical:

a. Enclosure shall be NEMA 4X (IP66). Where indicated on the drawings to be installed in hazardous locations, the transmitter shall be explosion proof approved for Class I, Division 1, Groups C and D (EEx d IIC).

b. Power supply shall be 24 VDC loop power.

4. Manufacturer(s):

a. Rosemount 3144P

b. ABB

c. Endress & Hauser

d. Approved equal

2.2 TEMPERATURE GAUGE

A. Type:

1. Bimetal type.

2. Manufactured to ANSI B 40.3 or equivalent standards.

B. Function/Pe3434rformance:

1. Range: Range as indicated on the instrument device schedule.

2. Accuracy: Plus/minus 1 percent of span.

3. Stem Length: Stem shall penetrate into the pipe where it is installed, by approximately 1/3 of the pipe diameter.

C. Physical:

1. Dial: Nominal 5 inches (125 mm), white painted steel with black markings.

2. Case: All welded stainless steel construction.

3. Window: Polycarbonate.

4. Element: 316 stainless steel.

D. Options/Accessories Require:

1. Swivel Head: Provide adjustable gauge position for viewing from any angle.

2. Thermometers shall be installed in 316L stainless steel thermowells. Thermowells shall be threaded accept for those installed in ozone system piping which shall be welded.

3. Extensions shall be provided for thermometers installed in insulated pipe. Extensions shall clear the pipe insulation.

E. Manufacturer(s):

1. Ashcroft

2. Reotemp

3. Weksler

4. Approved equal.

2.3 TEMPERATURE SWITCH

A. Type:

1. Bulb and capillary.

B. Function/Performance:

1. Set Point: Field adjustable and set between 20 and 80 percent of the adjustable range.

2. Deadband: Fixed deadband unless noted otherwise in the Instrument Device Schedule.

3. Reset: Automatic reset type unless noted otherwise in the Instrument Device Schedule.

4. Over Range Protection: Over range protection to maximum process line temperature.

5. Switch Rating: 15 amps at 250 VAC.

C. Physical:

1. Switch Housing: Remotely mounted. NEMA 4X (IP66) for non hazardous locations. Where indicated on the drawings to be mounted in hazardous locations, the switch housing shall be explosion proof, approved for Class I, Division 1, Groups C and D (EEx d IIC).

2. Switching Arrangement: Single pole double throw (SPDT) unless double pole double throw (DPDT) switches are indicated on the Instrument Device Schedule.

3. Wetted Parts: 316 stainless steel.

4. Bulb penetration into pipe shall be approximately 4 inches (100 mm) for pipe diameters less than or equal to 12 inches (300 mm) and approximately 7 inches (175 mm) for pipe diameters greater than 12 inches (300 mm).

5. The switch shall be UL listed.

D. Accessories Required:

1. Bulbs shall be installed in 316 stainless steel thermowells. Thermowells shall be threaded accept for those installed in ozone system piping which shall be welded.

2. Provide sufficient armored capillary tubing up to 15 ft (4.5 m) in length as required by the installation indicated on the drawings.

E. Manufacturer(s):

1. Ashcroft

2. Reotemp

3. SOR

4. Approved equal.

PART 3 EXECUTION

3.1 GENERAL

A. Install in conformance with manufacturer's requirements and as specified under Section 13400.

END OF SECTION

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SECTION 13446 – ELECTRIC OPERATORS FOR VALVES AND GATES

PART 1 GENERAL

1.1 SCOPE OF WORK

A. Furnish and install electric motor actuators (actuators) for valves and gates, as shown on the Drawings, as specified herein, and in Sections 15200 and 15250.

B. Related Sections

1. Section 01758 – Training Requirements
2. Section 01782 – Operating and Maintenance Data
3. Section 13410 – Process Instrumentation and Controls – General Provisions
4. Section 13421 – Programmable Logic Actuators and Computer Control Systems
5. Section 13433 – Pneumatic Valve Actuators
6. Section 15050 – Basic Mechanical Materials and Methods
7. Section 15110 – Valves - General Requirements
8. Section 15200 – Numbered Valve List
9. Section 15250 – Slide Gates, Stop Gates and Stop Logs
10. Control Schematic Drawings
11. Process and Instrumentation Drawings (P&ID's)

1.2 SYSTEM DESCRIPTION

A. All Type 1A and 1B chemical valve actuators shall be products of a single manufacturer. All 2A, 2B, 3A, 3B and 4A shall be of the same specified design.

B. All electric actuators furnished shall be of the TYPE # as required by Section 15200. Remote Actuator Control Stations shall be provided for actuators as required by the Section 15200 or the Electrical Drawings. Actuator TYPE # is assigned based on the following general characteristics.

TYPE #	Open / Close or Modulating Operation	Torque range	90 Degree or Multi-turn operation
1A	Open / Close	Low	90 Degree
1B	Modulating	Low	90 Degree
2A	Open / Close	Medium	90 Degree
2B	Modulating	Medium	90 Degree
3A	Open / Close	High	90 Degree

TYPE #	Open / Close or Modulating Operation	Torque range	90 Degree or Multi-turn operation
3B	Modulating	High	90 Degree
4A	Open / Close	High	Multi-turn
4B	Modulating	High	Multi-turn

C. The actuators furnished under this Section shall have all features and auxiliary components as specified in the paragraphs based on the TYPE specified.

D. The torque requirements of the actuator shall be as required to operate the valves of the sizes and against the specified pressures in accordance with AWWA C540 standards.

1.3 SUBMITTALS

A. Submittals shall be in accordance with the Standard and Special Provisions.

B. Submittals for actuators shall be identified with the actuator type as specified and cross-referenced to every valve and gate number as shown detailed on the Contract Documents.

C. As a minimum, submittals shall include at least the following:

1. Technical bulletins descriptive of the proposed actuators and all functions and available features. Clearly indicate those functions and features that will be provided for each valve actuator provided under this Contract.

2. Provide a separate scaled drawing for each actuator type in each of the available configurations of the actuator with complete dimensions and locations of controls and all connection points indicated. Tabulated or generic drawings are not acceptable for this requirement.

3. A complete bill of materials for each actuator.

4. Certified actuator torque sizing calculations detailing as a minimum the following:

a. Maximum required valve operating torque.

b. Maximum available actuator operating torque.

c. Torque rating of gearbox.

d. Sizing criteria.

e. Full stroke operating time for both opening and closing valve under the operating conditions included in the Contract Documents.

f. Name and organization preparing the calculations.

5. Certified factory test results for each actuator. Submittals shall include the following as a minimum for each actuator:

a. Test amperes for each phase

b. Torque production or confirmation of rating

c. Measured stroke time

d. Actuator serial number

6. Certified installation drawings showing details of the complete valve and actuator assembly including dimensions, weights and installation requirements.

7. Separate electrical and control drawing and details for each individual actuator showing the following as a minimum (standard catalogue cut sheets which show typical wiring diagrams are not acceptable):

   a. Actuator horsepower and power requirements.

   b. Control schematics (wiring diagrams) detailing all external interfaces.

   c. Conduit access locations

   d. Remote mount control station wiring diagrams and physical mounting requirements.

   e. For all actuator parameters which will be software configured, the submittal shall indicate the initial configuration settings that will be implemented to comply with the project requirements.

   f. Identification (project-specific valve number) of valve for which the actuator is proposed.

8. Submit details of the valve communications network. Details shall include specific part numbers and descriptive literature for expansion boards, firmware, or chipsets that are necessary for the networking capability. In addition, submit the following:

   a. Evidence that the actuator Electronic Device Description is certified and released by the HCF for use with a HART configurator.

   b. Details of the network protocol including communication medium requirements, wiring requirements, termination standards, device addressing strategy, database configuration, and dataset available for transmission over the network

   c. Distance or device number constraints for populating the network and associated impacts on bandwidth, speed, and throughput

   d. Memory or register addressing map of the valve data available for transmission on the network

9. Submit data sheets and features of the handheld actuator configuration device

10. Submit factory test report of the valve network test procedure

11. Submit field service reports for each actuator indicating the successful completion of and recording of all field startup and testing data.

12. Operating and maintenance manuals in accordance with Section 01782.

13. Training agenda and materials in accordance with Section 01758.

1.4 REFERENCE STANDARDS

A. American Waterworks Association (AWWA):

1. C540: AWWA Standard for Power Actuating Devices for Valves and Slide Gates

B. Highway Addressable remote Transducer (HART) Communication Foundation (HCF)

1.5 QUALITY CONTROL

A. The manufacturer shall provide a full extended warranty against defects in workmanship and materials on the complete actuator, gearbox and appurtenances for a minimum of 5 years. The extended warranty shall cover parts, on-site labor, travel and per diem costs, and shall not be pro-rated. Acceptable manufacturers and models are noted with the descriptions of each type (1A, 1B, 2A, etc.) of actuator in this Section when in compliance with the requirements herein.

B. Single source responsibility shall be provided for each electric motor actuator and valve assembly provided on this project. As a minimum, these responsibilities shall include the following: electric actuator sizing and selection, valve and electric actuator shop drawing preparation, factory mounting of the actuator and valve to adjust and test the complete assembly, field service, and warrantee of the complete electric actuator and valve assembly. Single source responsibility shall be provided by one of the following manufacturers or suppliers:

1. The valve or gate manufacturer for valve sizes 12-inch nominal diameter and larger and all gates.

2. The electric actuator manufacturer for valve sizes 10-inch nominal diameter and smaller.

3. An authorized distributor and service facility for the valves (and gates) having at least 5 years' experience in the servicing of the equipment furnished for the valve and gate sizes to be provided.

4. An authorized distributor and service facility for the electric actuator having at least 5 years' experience in the servicing of the equipment furnished for the 6-inch and smaller valve sizes.

C. Actuator manufacturer shall be listed as a member of the HART Communication Foundation.

1.6 OPERATING AND MAINTENANCE INSTRUCTIONS

A. Operating and maintenance instructions, for each type of actuator, shall be submitted to the Engineer in accordance with Section 01782.

B. Field startup and training of all actuators shall be performed by a field service technician employed by the actuator manufacturer. The field service technician shall be certified by the actuator manufacturer, shall be factory trained with complete knowledge of proper startup, installation, configuration and use of the handheld valve configuration device, operation and maintenance of the actuators furnished.

1.7 ACTUATOR TORQUE SIZING AND OPERATION

A. The actuator manufacturer shall prepare and submit an affidavit of compliance for each actuator and gearbox indicating that the complete actuator and gearbox assembly complies with the applicable provisions of the AWWA Standards C504 and C540 and the requirements of this Specification regarding torque sizing. Affidavit shall also include confirmation of opening and closing stroke times in conformance with the applicable published documentation.

B. The rated torque capability of each actuator assembly shall be at least 150% of the valve's maximum seating, un-seating, and dynamic torque. For modulation service valves, the rated torque capacity of the actuator assembly at the number of starts per hour shall be at least 150% of the valve's required torque. The valve's required torque shall be provided by the valve manufacturer and shall be defined as the torque required to seat, unseat, and rigidly hold the valve in any intermediate position and under the differential pressures and pipeline velocities shown. Unless the valve is required to isolate flow in both directions, the valve's required torque shall be for installation in the preferred direction only.

1.8 MAINTENANCE

A. Spare parts:

1. Furnish five percent (minimum of one) of each type of valve actuator (open/close type or modulating type; each voltage level) specified in this Section. Provide additional spare parts required for normal operation and maintenance of the valve actuators as recommended by the actuator manufacturer in accordance with Section 15050.

2. Spares shall be delivered to Owner before final acceptance of the system. Packaging of spares shall provide protection against dust and moisture and shall be suitable for storage. Circuit boards and other electronic parts shall be enclosed in anti-static material. All packages shall be clearly marked with manufacturer's name, part number, date of manufacturer and approximate shelf life.

B. Maintenance Accessories:

1. Furnish a minimum of four handheld configuration devices for remote setting and configuration of the actuators. Provide rechargeable, battery powered handheld devices with graphical display and firmware that allows full actuator configuration, storage of configuration parameters, and ability to download specific valve configuration parameters to a laptop computer via USB or comparable cable connections.

2. Provide all necessary ancillary cables, terminations, and connectors necessary for performing typical actuator configuration procedures. Provide a minimum of four spare battery packs and standalone battery docking charger.

1.9 GENERAL, ELECTRICAL, CONTROL AND INSTRUMENTATION RESPONSIBILITIES

A. Reference Section 15050 for specific responsibilities of this specification Section for furnishing, installing, and coordinating the electrical, control, and instrumentation work associated with the specified mechanical systems.

B. The quality and construction of electrical, instrumentation, and control equipment to be furnished under this Section shall conform to Section 15050; Division 16 in its entirety; and any specific requirements included within this Section.

C. Valve actuator shall support transmission of valve information and diagnostic data using the HART protocol superimposed on a standard 4-20 mA signal cable. Actuator HART interface and associated actuator Electronic Device Description shall be compatible with the HART Configurator device specified in Section 13410.

1.10 MEASUREMENT AND PAYMENT

A. Work shall be considered incidental and compensation shall be included in the Contract prices paid for the various items of work and no additional time or compensation be allowed therefor.

B. Refer to Article 20.01 Schedule of Bid Items.

PART 2 PRODUCTS

2.1 GENERAL ACTUATOR REQUIREMENTS

A. Unless otherwise noted, all actuators shall have the following general features in addition to the special features required under the specific “ACTUATOR TYPE” paragraphs.

B. All actuators shall include, but are not limited to, high torque reversible electric motor, worm gear reduction, mechanically and electrically interlocked reversing motor contactor, digital display for English characters and graphics, electronic torque sensor, absolute valve position encoder, hand wheel declutch lever, hand wheel, and local control switches as a self-contained unit. Electric valve actuators shall conform to AWWA C-540 except as modified herein.

C. Motor ratings: 480 VAC, 3 phase, 60 Hertz power; horsepower rating shall be continuous duty. Motor insulation shall be NEMA Class “F” or “H” with thermal overloads and service factor shall be a minimum of 1.0. Motor speed shall be 1800 rpm or 900 rpm.

D. The actuators shall be powered by 480 VAC, 3 phase, 60 Hertz power or 115 VAC, 1 phase, 60 Hertz power as shown on the electrical Drawings. Provide thermal protection internal to the motor in all cases.

E. Provide mechanical dial position indicator for local position indication with graduations in 0, 25, 50, 75 and 100%. Compression type terminal strips shall be supplied for all remote actuator power, control and indication connections and shall be manufactured by Phoenix Contact or equal. Control terminals shall be rated at 300 volts and accept an AWG 24-12 wire gauge range. 480VAC actuator power terminals shall be rated at 600 volts and accept an AWG 3-10 wire gauge range. The electrical compartment shall have a minimum of four 1-inch conduit entries for power, discrete control and instrumentation

wiring. The termination compartment shall be sealed separately from the internal actuator controls compartment to prevent the possibility of water intrusion into the actuator's control compartment from an open conduit or other means.

F. The controls including the reversing motor starters, pushbuttons, control power transformer, and shall be housed in the actuator enclosure. The actuator gear housing shall be of high strength cast iron and grease lubricated. Aluminum oil lubricated actuator gear housings are not acceptable. The actuator controls housing shall be of high strength cast iron or aluminum design. Housing construction shall be designed to meet NEMA 4X and 6P waterproof and submersible requirements.

G. Where specifically shown on the valve index as subject to submergence, provide actuator housing rated IP 68-3 minimum. Provide additional corrosion resistance material and corrosion protection for the actuator, gearboxes and coupling compartments. Valves shown as subject to submergence shall be fully rated and certified by the manufacturer for this applications.

H. Valve position shall be sensed by an optical, absolute position encoder with redundant position sensing circuits designed for built-in self-testing. Open and closed positions shall be stored in permanent, nonvolatile memory. The absolute position encoder shall be capable of resolving plus or minus 7 degrees or better of output shaft position over 10,000 output drive rotations.

I. Reduction gearing and motor speed for valve actuators shall be selected by the actuator manufacturer to provide approximately a 60 second full stroke operating time per 12 inches of valve size unless noted otherwise on the Drawings or Specifications or recommended by the valve manufacturer.

J. All external hardware and anchor bolts shall be type ASTM A276 304 stainless steel.

K. Valve actuator shall be equipped with an adjustable electronic torque sensor that shall de-energize the motor if tripped. Functions shall be provided to prevent torque trip during initial valve unseating.

L. The actuator shall be suitable for operation in ambient temperatures from 40°F to 120°F.

M. The control system shall include provision for adjusting valve position in both opening and closing directions by "jogging". When the valve shall be operated to full open or closed, jogging shall not be required nor should it be a means of meeting open or close cycle times. Provide analog or discrete control as required by the Drawings as well as analog position and torque transmission.

N. The actuator shall have a capability of both manual and motorized operation; a hand wheel with spindle shall be used for manual operation, which shall not rotate during motor operation. Manual actuators shall be capable of holding the valve in any position without creeping or fluttering. A permanently attached handwheel with spindle shall be provided for manual operation. The handwheel shall not rotate during electrical operation. The maximum torque required on the handwheel under the most adverse conditions specified herein shall not exceed 60 lb-ft, and the maximum force required on the rim of the handwheel shall not exceed 40 lb. An arrow and either the word “open” or “close” shall be indicated on the handwheel. A declutch mechanism shall be supplied for manual operation. The maximum rim pull force required for manual operation using handwheels or chain wheels shall be 40 pounds.

O. Non-metallic or cast gearing shall not be allowed. Tapered roller bearings shall be used to provide smooth rotation of the worm. All gearing shall be grease lubricated. Electric actuator output speed changes shall be possible by removing the motor and changing the exposed helical gear set ratio with further disassembly of the electric motor. The actuator shall have a device incorporated in the power train located between the worm gear and actuator drive sleeve, to permit load impact under static efficiency conditions, with hammer-blow effect to allow the motor to reach full speed before engaging the load.

P. The motor actuator and intermediary gear boxes shall have a minimum service life of 250,000 output turns of the motor actuator at 30% of rated torque plus rated torque seating 5,000 times in both directions.

Q. An integrally mounted and NEC compliant fused control power transformer shall be provided to power the actuator controls at a maximum of 120 VAC for 480V rated actuators; 120 VAC, single phase actuators shall derive control power from dedicated, fuse protected control circuitry.

R. Provide a space heater in the actuator housing to prevent condensation and moisture accumulation.

S. Actuator Control Stations:

1. Provide control stations: LOCAL - OFF - REMOTE selector switch, OPEN - STOP - CLOSE pushbuttons and OPEN - CLOSE indicating lights integral with the actuator housing. The control station shall be capable of being easily field rotated in 90° increments to orient the control station in a “heads up” display direction and to allow remote configuration using the hand held configuration tool from finished floor, deck, or grade. Access to the actuator by a ladder for configuration shall not be acceptable.

2. Remotely mounted control stations: Where shown on the Drawings, Section 15109, or when required to comply with the control station accessibility criteria, provide valve actuators with control stations suitable for mounting remotely from, but, in the vicinity of the actuator. Remote mounted control station shall include a LOCAL - OFF - REMOTE selector switch, OPEN - STOP - CLOSE pushbuttons and OPEN - CLOSE indicating lights.

3. Control station actuators shall be heavy duty full-size devices mounted in a cast iron, cast aluminum, or stainless steel NEMA 4X enclosure suitable for wall or stanchion mounting. Pushbuttons and indicator lights shall be Allen-Bradley Bulletin 800H, or equal.

4. Provide LOCAL - OFF - REMOTE selector switches with auxiliary contacts for remote indication of switch position.

5. Provide LOCAL - OFF - REMOTE selector switches with provisions for padlocking in the OFF position.

6. Provide LED type indicator lights.

7. Remote control stations where shown on the Drawings, shall be furnished by the actuator manufacturer

T. Provide actuators with contacts for remote control and position indication. Position and torque status contacts shall be independently adjustable. Provide position contacts in the quantity as shown on the Drawings with a minimum of four open position and four close position single pole, single throw contacts.

U. Integral controls shall include a phase correction device to monitor incoming power to ensure proper motor direction corresponding to either an open or close command.

V. Provide Bluetooth or equivalent wireless communication interface for remote access to and modification of actuator configuration parameters. Communication protocol shall be compatible with the battery powered handheld configuration devices as specified.

W. Provide actuator network interface for remote status and diagnostic purposes through the facility's process control system specified in Section 13400 in addition to the contact and signal interfaces specified.

1. Provide actuator network interface based on bidirectional communication protocol operating at a minimum of 1200 bits/sec. Provide Highway Addressable Remote Transducer (HART). Actuator communication interface shall be certified for use by the HART Communication Foundation (HCF).

2. Provide HART based protocol superimposed on the 4-20 mA signal wiring to each modulating valve and on a dedicated signal cable for open/close actuators as shown on the Drawings.

3. Actuator network interface shall provide additional monitoring information including at a minimum:

a. Valve torque profiles

b. Operational Start Profiles

c. Operational Trend Logs

d. Event Log

e. Running Times

f. Average Torque

g. Start/Operations Counter

2.2 ELECTRICAL CONTROLS FOR OPEN – CLOSE ACTUATORS (TYPE 2A, 3A & 4A)

A. The actuator shall contain an integral reversing motor starter suitable for receiving OPEN - STOP - CLOSE commands in the form of momentary dry contact closures. The actuator starter shall cause the valve to move in the appropriate direction until stopped by the actuator position switches or stop control (or torque switch for torque seated valves). Starters shall have auxiliary "seal in" contacts as required to implement the control action.

B. Electromechanical starters shall be mechanically and electrically interlocked.

C. Type 3A and 4A shall have a 4-20 mA valve position output signal for remote indication of valve travel position.

D. Refer to the Instrumentation P&IDs and Electrical Drawings for additional control package requirements.

2.3 ELECTRICAL CONTROLS FOR MODULATING ACTUATORS (TYPE 2B, 3B & 4B)

A. The actuator shall contain an integral position control system. The control system shall be capable of receiving an external 4-20 mA input setpoint signal corresponding to optimum valve position or process control setting and comparing this to an internally generated feedback signal corresponding to valve position to provide the actual deviation signal to the motor actuator. The actuator shall automatically adjust the position of the actuator when the error in the comparison of setpoint to feedback is greater than the deadband of the actuator. The deadband shall be preset by the manufacturer but shall be field configurable.

B. The actuator shall have a “loss of command signal” protection. The actuator shall be selectable to lock in the last signal or to lock in a preset valve position.

C. The actuator shall have a 4-20 mA valve position output signal for remote indication of valve travel position.

D. The actuator control unit output shall drive the electromechanical reversing starter to position the actuator motor. Electromechanical contactors shall be mechanically and electrically interlocked.

E. The starter and control unit shall be rated for continuous modulating applications of a minimum of 1200 starts per hour.

F. The LOCAL - OFF - REMOTE switch shall simultaneously select both the operating mode and signal source. In the REMOTE position, the actuator shall position the valve based on the remotely generated 4 - 20 mA signal. In the LOCAL position, the controls shall position the valve based on the locally mounted OPEN - STOP - CLOSE pushbutton station.

G. Refer to the Instrumentation P&IDs and Electrical Drawings for additional control package requirements.

2.4 TYPE 1A ACTUATOR (LOW TORQUE – OPEN/CLOSE – QUARTER TURN VALVE TYPE) FOR USE ON METALLIC VALVES

A. Actuators shall comply with all requirements of Paragraph 2.01 except as modified in this section.

B. The actuator is not required to be microprocessor based; actuator is not required to be on the actuator communication network,

C. Actuators shall have a published running torque range from approximately 100 pound - inches to 1000 pound - inches.

D. The motor shall be a 115 volt single phase split- capacitor type with integral auto - reset overload protection and class B insulation suitable for a minimum of 360 starts per hour.

E. The unit shall have controls as specified for Open - Close actuators.

F. Each actuator shall be furnished with a control enclosure, factory assembled and wired to the actuator. The control enclosure shall contain a motor power disconnect switch, open and close starter as detailed on the electrical drawings. The power disconnect shall be a horsepower rated fractional horsepower motor starter switch. The starters shall have replaceable contacts rated for the motor starting duty of the actuator. The control enclosure shall be rated NEMA 4X.

G. Auxiliary contacts that are required to implement the control action shall be provided by the actuator manufacturer and may be either shaft driven limit switches or auxiliary control relay contacts. Control relays shall be housed in the actuator housing or in an auxiliary equipment enclosure. If an auxiliary enclosure is required for housing control relays, it shall be factory mounted and wired to the actuator enclosure. Auxiliary enclosures may be fabricated of sheet steel but shall have the same NEMA rating as the actuator housing.

H. Torque switches need not have a field calibration indication mechanism if they are factory adjusted and sealed.

I. Manual operation handwheels need not have a separate declutching lever if the actuator incorporates alternative design features to prevent injury to personnel during manual operation.

J. Electric actuators shall be Elomatic EL series, Bettis, or equal.

2.5 TYPE 1A ACTUATOR (LOW TORQUE – OPEN/CLOSE – QUARTER TURN VALVE TYPE) FOR USE ON PLASTIC BALL VALVES

A. Actuators used on chemical systems plastic ball valves are not required to comply with the requirements of Paragraph 2.01.

B. The actuator is not required to be microprocessor based; actuator is not required to be on the actuator communication network.

C. The housing shall be both explosion-proof and weatherproof. The aluminum die-cast housing shall be electro-static polyester powder coated for corrosion resistance. Suitable conduit entries shall be provided for the size and number of conduits shown on the plan drawings. The cover shall include stainless steel captive cover bolts to prevent loss of bolts when the cover is removed

D. Provide single phase, permanent split capacitor gear motor with 115 VAC input; Maximum current draw: 0.9 Amp.

E. Actuator shall contain a permanently lubricated, precision cut, heat treated alloy steel gear train designed to withstand motor stall torque.

F. Travel limit switch cams shall be extra wide, spring loaded and splined so that Open/Close positions can be set without special tooling, and contain a micro adjust screw for very precise applications.

G. Provide an automatic electrical cut-off switch is provided to prevent electrical operation while the manual override is engaged.

H. Actuators shall have a published running torque range from approximately 250 – 1500 in-lbs.

I. Provide manual operating handwheel or lever.

J. Provide minimum of four position (limit) switches for remote indication of open-close position.

K. Electric actuators used on plastic valves shall be NIBCO Series 300 or equal.

2.6 TYPE 1B ACTUATORS (LOW TORQUE – MODULATING – QUARTER TURN VALVE TYPE)

A. Actuators shall comply with all requirements of Paragraph 2.01 except as modified in this section.

B. The actuator is not required to be microprocessor based; actuator is not required to be on the actuator communication network.

C. Actuators shall have a published running torque range from approximately 100 pound - inches to 1000 pound -inches.

D. The motor shall be a 115 volt single phase split-capacitor type with integral auto - reset overload protection and class B insulation suitable for a minimum of 1200 starts per hour.

E. The actuator shall have the following modulating controls:

1. The actuator shall contain an integral position control system. The control system shall be capable of receiving an external 4-20 mA input setpoint signal corresponding to optimum valve position or process control setting and comparing this to an internally generated feedback signal corresponding to valve position to provide the actual deviation signal to the motor actuator. The actuator shall automatically adjust the position of the actuator when the error in the comparison of setpoint to feedback is greater than the deadband of the actuator. The deadband shall be factory set but shall be field adjustable.

2. The actuator control unit shall be solid state.

3. The control shall contain a loss of command signal protection selectable to lock in last or lock in preset valve position.

4. The control shall contain a 4-20 mA valve position output signal for remote indication.

5. The actuator control unit output shall drive a solid state, reversing starter to position the actuator motor. Solid state starters shall be designed for minimum susceptibility to power line surges and spikes and shall be tested to 6,000 VAC as specified by IEEE C62.41.

6. The starter and control unit shall be rated for continuous modulating applications of a minimum of 1200 starts per hour.

7. The LOCAL - OFF - REMOTE switch shall simultaneously select both the operating mode and signal source. In the REMOTE position, the actuator shall position the valve based on the remotely generated 4 - 20 mA signal. In the LOCAL position, the controls shall position the valve based on the locally mounted OPEN - STOP - CLOSE pushbutton station.

8. Refer to the Instrumentation P&IDs and Electrical Control Schematic Drawings for additional control details.

F. Each actuator shall be furnished with a custom fabricated control enclosure which shall be factory assembled and wired to the actuator. The control enclosure shall contain a motor power disconnect switch, position control system, open and close starter as detailed on the electrical drawings. The power disconnect shall be a horsepower rated fractional horsepower motor starter switch. The starter shall have replaceable contacts rated for the motor starting duty of the actuator. The control enclosure shall be rated NEMA 4X.

G. Auxiliary contacts that are required to implement the control action shall be provided by the actuator manufacturer and may be either shaft driven limit switches or auxiliary control relay contacts. Control relays shall be housed in the actuator housing or in an auxiliary equipment enclosure. If an auxiliary enclosure is required for housing control relays, it shall be factory mounted and wired to the actuator enclosure. Auxiliary enclosures may be fabricated of sheet steel but shall have the same NEMA rating as the actuator housing.

H. Torque switches need not have a field calibration indication mechanism if they are factory adjusted and sealed.

I. Manual operation handwheels need not have a separate declutching lever if the actuator incorporates alternative design features to prevent injury to personnel during manual operation.

J. Electric actuators used on Chemtrol plastic valves shall be NIBCO Series 300, no equal.

K. Electric actuators used on other brand valves shall be Elomatic EL series, Bettis, or equal.

2.7 TYPE 2A ACTUATOR (MEDIUM TORQUE – OPEN/CLOSE – QUARTER TURN VALVE TYPE)

A. Actuators shall comply with all requirements of Paragraph 2.01 except as modified in this section.

B. Actuators shall have a published running torque range from approximately 200 foot-pounds to 1,200 foot-pounds.

C. Actuators that do not employ internal quarter-turn gear sets shall be furnished with and mounted to a quarter turn worm gear box suitable for direct mounting on the valve stem. Each gear box shall comply with AWWA C540.

D. The unit shall have controls in accordance with Paragraph 2.02 Electrical Controls for Open - Close Actuators.

E. Electric actuators shall be

1. Limitorque (Flowserve Corporation), QX series with quarter turn gear box

2. AUMA SA/GS Series with quarter turn gear box

3. No others equal

2.8 TYPE 2B ACTUATOR (MEDIUM TORQUE – MODULATING – QUARTER TURN VALVE TYPE)

A. Actuators shall comply with all requirements of Paragraph 2.01 except as modified herein.

B. Actuators shall have a published running torque range from approximately 200 foot-pounds to 1,200 foot-pounds.

C. Actuators that do not employ internal quarter-turn gear sets shall be furnished with and mounted to a quarter turn worm gear box suitable for direct mounting on the valve stem. Each gear box shall comply with AWWA C540.

D. The unit shall have controls in accordance with Paragraph 2.03 Electrical Controls for Modulating Actuators.

E. Electric actuators shall be:

1. Limitorque (Flowserve Corporation), QX series with quarter turn gear box

2. AUMA SA/GS Series with quarter turn gear box

3. No others equal

2.9 TYPE 3A ACTUATOR (HIGH TORQUE – OPEN/CLOSE – QUARTER TURN VALVE TYPE)

A. Actuators shall comply with all requirements of Paragraph 2.01 except as modified herein.

B. Actuators shall have a published running torque range from approximately 100 foot-pounds to 20,000 foot-pounds.

C. The actuator shall be mounted to a quarter turn worm gear box suitable for direct mounting on the valve stem. The gear box shall comply with AWWA C540.

D. The unit shall have controls in accordance with Paragraph 2.02 Electrical Controls for Open - Close Actuators.

E. Electric actuators shall be:

1. Limitorque (Flowserve Corporation), MX series with quarter turn gear box

2. AUMA SA/GS Series with quarter turn gear box

3. No others equal

2.10 TYPE 3B ACTUATOR (HIGH TORQUE – MODULATING – QUARTER TURN VALVE TYPE)

A. Actuators shall comply with all requirements of Paragraph 2.01 except as modified in this section.

B. Actuators shall have a published running torque range from approximately 100 foot-pounds to 20,000 foot-pounds.

C. The actuator shall be mounted to a quarter turn worm gear box suitable for direct mounting on the valve stem. The gear box shall comply with AWWA C540.

D. The unit shall have controls in accordance with Paragraph 2.03 Electrical Controls for Modulating Actuators.

E. Electric actuators shall be:

1. Limitorque (Flowserve Corporation), MX series with quarter turn gear box

2. AUMA SA/GS Series with quarter turn gear box

3. No others equal

2.11 TYPE 4A ACTUATOR (HIGH TORQUE – OPEN/CLOSE – MULTI-TURN LARGE GATE TYPE)

A. Actuators shall comply with all requirements of Paragraph 2.01 except as modified in this section.

B. Actuators shall have a published running torque range from approximately 100 foot-pounds to 6,000 foot-pounds.

C. The actuator shall have a stem nut of high tensile bronze or other material, compatible with the stem and suited to the application. The nut arrangement, where possible, shall be of the two-piece type to simplify field replacement. The stem nut for rising stem gates must be capable of being removed from the top of the actuator without removing the actuator from the gate, disconnecting the electrical wiring, or disassembling any of the gearing within the actuator.

D. The unit shall have controls in accordance with Paragraph 2.02 Electrical Controls for Open - Close Actuators.

E. Gear box shall be provided if needed for the specified torque or time limits.

F. Electric actuators shall be:

1. Limitorque (Flowserve Corporation) MX series

2. AUMA 5A series

3. No others equal

2.12 TYPE 4B ACTUATOR (HIGH TORQUE – MODULATING - MULTI-TURN LARGE GATE TYPE)

NOT USED

2.13 ACTUATOR MOUNTING BRACKETS

A. When Type 2 or 3 actuators are utilized on small valves (4 inches and smaller) the actuator shall be equipped with separate mounting brackets to support the actuator weight independently of the piping and valve system. The bracket shall be a factory fabricated from1/4" carbon steel (minimum), galvanized after fabrication, and factory assembled between the actuator and the valve. The actuator stem and coupling shall be of sufficient length to accommodate the 1/4" plate.

B. All actuator and valve assemblies shall be match marked during shop mounting with indelible markings to illustrate proper relative orientation and facilitate disassembly and reassembly in the field.

C. Actuator mounting brackets shall be designed, fabricated and furnished by the actuator or valve supplier as identified in PART 1 of this Section.

2.14 FACTORY TESTING

A. All actuators shall be inspected and tested at the factory by the actuator manufacturer. Results of these tests shall be submitted to the Engineer as specified.

B. Factory testing shall include verification of the valve communication network specified.

1. Testing shall include verification of network performance that meets or exceeds the actuator manufacturer’s published speed and bandwidth data.

2. Factory testing shall include verification of delivery of all status and control data for network resident valves.

PART 3 EXECUTION

3.1 INSTALLATION

A. All electric actuators shall be properly supported, in addition to piping and valve supports, to minimize load on valve and piping system.

B. Actuator supports shall allow access to all controls and internal components without removal of actuator support.

C. Actuators shall be oriented so that the front LED panel is easily accessible for startup and configuration, and lettering is horizontal and not inverted.

D. Where actuators must be mounted at locations that are not accessible from finished floor levels, orient actuators

3.2 COATINGS

A. Actuators for gates and valves shall be industrially coated with coating systems suitable for exterior exposure in accordance with Section 09900.

B. Field painting and coating shall include touch-up work to repair any damage to shop painting or coating.

3.3 SHIPPING, HANDLING, DELIVERY AND STORAGE

A. Refer to the Standard Provisions for additional information.

B. Care should be taken in loading, transporting and unloading to prevent injury to the actuator. All equipment shall be examined before installation. Equipment that is found to be defective shall not be installed.

3.4 FIELD INSPECTION, ADJUSTMENT, STARTUP AND TESTING

A. Field inspection, adjustment, startup and testing shall be in accordance with Section 15050, in addition to the following requirements.

B. The actuator manufacturer's field service technicians shall inspect, adjust, startup and test all actuators furnish under this project. Services of a valve field service technician are not sufficient to meet this requirement. A separate field report shall be prepared and submitted for each actuator. Field service shall include the following as a minimum for each actuator:

1. Adjust and record the setpoints for all position and torque sensors.

2. Measure and record actuator operating voltage and amps during three full operating cycles of the valve.

3. Confirm proper operation of all field interface signals.

4. Confirm that all conduit openings into the actuator are sealed.

5. Confirm that the actuator and gearbox are filled with the proper types of lubricant.

6. Readjust valve setpoints a minimum of one additional time for 75 percent of the valves with actuators as directed solely by the Engineer to aid in loop tuning and associated work.

C. Add: Field testing to verify delivery of all data over the network interface to the City's networking interfaces, as shown on the Drawings.

D. Correction of deficiencies shall be in accordance with Section 15050.

E. Provide the following field service technician duties at a minimum. Provide more time as required or as recommended by the actuator manufacturer(s).

FIELD SERVICE TECHNICIAN DUTIES

Services Provided by Actuator Field Service Technician	Minimum Number of Trips (see Note A)	Minimum Time on Site (see Note A) (8 hr. working days of time actually on-site)
1. Field investigations, supervise, and complete installations	2	1 day
2. Inspect and approve installations	1	1 day
3. Perform startup adjustments and checks	2	2 days or 30 minutes per actuator, whichever is longer
4. Perform testing	As required by Contractor's startup plan	As required by Contractor's startup plan
5. Instruct City Staff in Proper Startup and O&M; Address valve network data access and equipment configuration	(see Note B)	(see Note B)

Note A: The actuator field service technician shall be present at whatever intervals are necessary to ensure proper installation testing and initial operation of the equipment.

Note B: See Section 01758 and Standard Provisions for training requirements.

F. Submit all field test results to the Engineer within 10 calendar days of tests.

END OF SECTION

SECTION 13482 – PROCESS CONTROL DESCRIPTIONS

PART 1 GENERAL

1.1 SCOPE OF WORK

A. Develop the control system applications to implement the operational control descriptions for all systems. All programmable logic controller (PLC) controller programming, communication networks, and Human Machine Interface (HMI) graphics and programming shall be performed by the PCSI designated in Section 13400. This Section is provided to clarify control strategies to be used to program the system.

B. The Contract Documents are a single integrated document, and as such all Divisions and Sections apply. It is the responsibility of the Contractor and Subcontractors to review all sections to insure a complete and coordinated project.

C. The PCSI is cautioned to review this section thoroughly prior to starting any programming. Many general control strategies and programming requirements are defined once in the body of this Section. The PCSI shall implement these general strategies throughout the programming provided under this Contract unless specifically directed otherwise in the detailed Process Control Descriptions included in Appendix 13482-A.

D. City loop and device tagging criteria shown on the Drawings shall be followed without exception.

E. Programming approach, database/variable identification criteria, graphics and other SCADA requirements shall match existing City standards. The City standards shall be followed without exception. Identification criteria and other City-specific programming including memory mapping, data array configuration, and addressing requirements and standards shall be provided to the PCSI following Notice To Proceed. The requirements shall be reviewed and discussed by the PCSI at the first SCADA coordination meeting as specified in Section 13400 to indicate understanding and acceptance of the standard approach.

F. Changes and additions to the existing PLC programs shall be performed by the PCSI. Modifications to these existing controls shall include but not be limited to the following:

1. Modifications to the programs running on existing PLC shall be made by the PCSI as shown on the Contract Documents.

2. Existing PLC programming at the WWTP have been developed using Modicon Unity software. PLC program additions and modifications at the existing PLC system shall be developed using Unity programming software for all changes made under this Contract. The Unity programs developed for the existing PLC system shall be designed using the same tagging, structures, functions, and format that are used to develop the Unity programs for the new PLC systems provided under this Project.

3. PLC program modifications shall be made offline and tested prior to installation in the existing PLC system. Program modifications shall be added to the existing program in such a way that the new logic can be switched into operation and the existing logic shall be switched off. Once the process areas and equipment for the

existing systems have been removed from service, and upon approval to proceed by the City, the program logic and the logic switching mechanism associated with the removed systems shall be removed from the PLC program.

4. Existing PLC tagging and addressing shall be retained and new PLC tagging and addressing developed to match the existing tagging scheme as defined in the Contract Documents.

G. Existing PLC and HMI equipment programming and application at the City's existing SCADA Central shall be modified and updated to incorporate the HMI monitoring and control included under this Contract.

H. PLC to PLC communications

1. Where data from the new PLC systems are required for use in the existing PLC (e.g., process permissives, etc.), the communication control logic shall reside in the existing PLC system. Unused register blocks in the existing PLC shall be allocated for this purpose.

2. Where data from the existing PLC system is required in the new PLCs, the communication control logic shall reside in the new PLC system. The PCSI shall pack data into unused contiguous register tables for transfer to each of the new PLC systems. The logic required to copy data from existing registers into the data transfer area shall be added by the PCSI as part of their PLC programming and testing.

I. Sludge drying system equipment PLCs and Graphical User Interface (GUI) displays programming shall be completed by the Sludge Drying System Supplier as required per Section 11600. Development of the SCADA HMI interface for monitoring and integrated control of the sludge drying system is the responsibility of the PCSI. The PCSI shall coordinate development of the graphic displays such that the HMI graphics are similar in arrangement and function to the GUI graphics that are developed by the Sludge Drying System Supplier.

J. Screw conveyor system equipment PLCs and Graphical User Interface (GUI) displays programming shall be completed by the Screw Conveyor System Supplier as required per Section 14552. Development of the SCADA HMI interface for monitoring and integrated control of the screw conveyor system is the responsibility of the PCSI. The PCSI shall coordinate development of the graphic displays such that the HMI graphics are similar in arrangement and function to the GUI graphics that are developed by the Screw Conveyor System Supplier.

K. Blower system equipment PLCs and GUI displays programming shall be completed by the Blower System Supplier and Aeration Control System as required per Sections 11502 and 13550. Development of the SCADA HMI interface for monitoring and integrated control of the blower system is the responsibility of the PCSI. The PCSI shall coordinate development of the blower system graphic displays such that the HMI graphics are similar in arrangement and function to the GUI graphics that are developed by the Blower System Supplier.

L. Intelligent electrical distribution equipment including unit substations, switchgear, standby generators, power monitoring, ASD's, and motor control centers, that are connected to the plant SCADA network, as shown on the Drawings, shall interface directly to the SCADA servers. Selected data from the electrical equipment, as determined during the Workshops, shall be collected by the SCADA historian.

Coordinate interfaces to other systems upon final decisions by City regarding data mapping criteria. Include power monitors, standby generators, smart distribution equipment, smart MCCs, smart ASDs all as specified in this Section.

1.2 RELATED WORK

A. Section 11205 – Submersible Compact Mixers

B. Section 11206 – Submersible Low Speed Mixers

C. Section 11220 – Mixers, General

D. Section 11502 – Geared Single Stage Centrifugal Blowers Packages

E. Section 11600 – Biosolids Dryer System

F. Section 13400 – Process Instrumentation and Control - General Provisions

G. Refer to Appendix 13482-A for Specific Process Control Descriptions

H. Section 13550 – Aeration Control System

I. Section 14552 – Screw Conveyor – Modifications and Improvements

J. Section 16230 – Standby Diesel Engine Driven Generators

K. Section 16260 – Low Voltage Variable Frequency Motor Controllers

L. Section 16290 – Electrical Power Monitoring System

M. Section 16350 – Medium Voltage Switchgear

N. Section 16436 – 480 Volt Switchgear

O. Section 16442 – Motor Control Centers

PART 2 PRODUCTS (NOT USED)

PART 3 EXECUTION

3.1 GENERAL

A. The loop descriptions included in Appendix 13482-A are sorted by loop/device number.

B. The loop descriptions are broken into a hierarchical layer concept:

1. There may be one layer or multiple layers per loop, depending upon the specific requirements and characteristics of that loop.

2. An example of a multiple layered loop is as follows:

a. The lowest layer of control, local control, is at that piece of equipment or that piece of equipment's panel or drive.

b. The second layer of control is the Local Control Panel (LCP) if applicable.

c. The third layer of control is at the Motor Control Center or Adjustable Speed Drive as applicable.

d. The fourth layer of control is at the PLC OIT or graphical user interface provided by the package system supplier.

e. The highest layer of control is the remote control functionality located at the Brentwood WWTP HMI

3. HMI refers to the computer based control computers configured with a graphical interface to the SCADA System for implementing all operator-required tasks as described herein. Functions labeled under the HMI shall be accessible at all the SCADA HMIs.

3.2 GENERAL PROGRAMMING REQUIREMENTS

A. The requirements specified herein represent general programming and control loop requirements to be followed by the PCSI for all programming efforts provided under this Contract. These general configuration and control requirements shall be used in conjunction with the detailed process control loop descriptions included in the following Appendix 13482-A to provide the complete process control loop functionality. The detailed process control loop descriptions do not describe the common configuration and programming requirements and conversely, these general requirements do not address process control specifics unique to a specific loop. However, if conflicts occur between these general requirements and the detailed process control descriptions, the detailed requirements shall be followed.

B. The HMI refers to the computer based graphical interface for implementing all operator required tasks as described in these Specifications. The HMI sends and receives data to a process controller based control system. The process controllers control and monitor the process equipment (pumps, valves, flowmeters, field sensors, etc.) through the input and output of electrical signals. In general, only loops requiring process controller and/or HMI programmed logic are described in the following control loops. Hardwired, relay based control schemes where required are included on the schematic control diagrams included on the Drawings and are only generally described in this Section.

C. PLC programs shall be developed using Function Block Diagram or Relay Ladder Logic and follow the program scheme and logic structure to match existing City PLC programs. Use of other IEC programming languages is prohibited.

D. All processor programs shall be configured to allow modification of set points, timers, etc. readily by plant personnel using the HMI as identified in the loop descriptions. Logic in the processor program shall be configured to allow modification using the programming devices and software either provided under this Contract and/or existing devices and software as described under Section 13400. All plant control and alarm logic shall be resident in the processors. The system shall continue to operate properly in automatic mode upon failure of the HMI servers.

E. All HMI “push button” inputs to the PLC shall be programmed to turn the associated memory bit in the PLC “ON” and upon completion of the required action, turn the associated memory bit “OFF”. The PLC internal logic shall sense the bit ON upon completion of the associated required action. Reset of the bit shall typically occur within one PLC programming scan.

F. Any operator entered setpoint change shall include verification logic within the HMI that requires a second, positive selection of the action by the operator prior to performing the command. Setpoint controls shall be configured in the HMI to be limited to a predefined range so that values that are unreasonable or outside of the operating range of the associated device cannot be entered. Other operator controlled operations (e.g., pump start/stop, open/close valve control) shall in general not require the second positive action. Selection of a control point shall also present the last valid set point or command sent to the device.

G. Incorporate failure of sequence logic to alarm upon incomplete or malfunction if the required operation does not occur within an adjustable time period initially set at 10 seconds. Sequence failure alarm shall put the associated device(s) in FAIL mode if a control system command, either manual or automatic, is not verified by the appropriate action of the device. For example, if a valve is called to open and confirmation of the open valve is not received after the adjustable time period, issue a valve failure alarm; if a motor is called to run and confirmation of the running motor is not received after the adjustable time period, issue a motor start malfunction alarm. Provide initial failure logic timers set at 10 seconds for motors and 90 seconds for valve open/close operation. Modify fail logic timer based on specifics of the controlled components.

H. Motors that have an H/O/A, L/O/R, or other control mode shown on the Drawings shall indicate at the HMI that the pump is being run in the respective active position (i.e. “Hand”, “Auto”, “Local”, or “Remote” positions). Incorporate a “Ready” state for each controlled device indicating the switch hierarchy is in the appropriate “Remote” and “Auto” positions with the equipment “Not Failed” and any operational permissives met so that control from the PLC is feasible.

I. When a power failure occurs the systems shall fail OFF, OPEN, CLOSE, or other Engineer determined safe position as identified in the loop descriptions or determined during the programming coordination workshops specified in Section 13400. PLC controlled equipment shall be restarted automatically to re-establish the process when power is restored. Motor restart after power failure shall include user adjustable time delays (0-60 seconds) to allow stagger starting of motor loads to limit inrush currents. Motor restart time delays shall only be active following a power failure restart.

J. Control logic for motors shall be programmed so if a motor stops for any reason, it shall not be re-started automatically once the problem with the motor has been resolved. The start command on the HMI shall be a maintained contact from the PLC. Motor restart after stopping will occur only after the operator reinitiates the start command for that motor locally or at the HMI; or when that motor control at the starter and at the HMI is in “Auto” or “Remote” and the SCADA computer through logic/interlocks or the operator calls for that motor to run.

K. PLC based Proportional-Integral-Derivative (PID) controllers shall be tuned by the PCSI during Operational Readiness Testing. Tuning of the controllers shall provide either critically-damped or over-damped response, as directed by the engineer, over the entire normal operating range of the control loop. All PID parameters required for tuning and controlling the behavior of the PID controller shall be available at the HMI and shall be accessible by City personnel that are authorized to modify PID functions. PID development shall include a setpoint alarm triggered when the setpoint deviates from the process variable by more than an adjustable deviation band for longer than an adjustable time duration.

L. All alarms shall display on a process control graphic and also tabulated on a common alarm screen. All alarms must be acknowledged by the plant staff before they can be cleared. No alarm shall clear automatically until it has been acknowledged.

M. All analog points brought into the process controller shall incorporate variable range alarms at the HMI. Set variable range alarms (low-low, low, high, and high-high) at 10%, 20%, 80%, and 90% of field instrument calibrated span unless specifically noted otherwise in the detailed loop descriptions or instrument list. All adjustable alarm set points shall be password protected.

N. All analog inputs shall be configured for presentation on trend screens of related variables and stored in the historical data system.

O. When an analog signal goes outside the 4-20 mA range due to a failure at the instrument, controller I/O module, system wiring failure, or other means, the following SCADA programming shall take place:

1. Issue a loop failure ALARM.

2. If the analog signal is associated with a control loop or ratio control loop that loop shall go into manual control mode.

3. If the analog signal is used in a calculation, that calculation shall use the last valid analog signal. The computer shall place the control loop in manual if using the calculation as part of the control logic.

P. All setpoints for controls, shutdown conditions, alarms, etc. derived from analog signals conditions shall be individually configured with adjustable deadbands (initially set at 3% deviation from set point) and time delays (initially set at 5 seconds) to avoid nuisance tripping and assist with system startup. Where duplicate/redundant instruments are provided for process reliability, provide deviation alarms when the signals of the two instrument outputs deviate by more than an adjustable deviation alarm percentage, initially set at 5%.

Q. Historical Data Collection - All analog inputs, operator process control setpoints, and discrete equipment ON/OFF status shall be collected and stored in the Historian database and incorporated on fixed trend screens of related variables. Historical data collection shall be configured to match existing City historian operation.

R. Provide flow totalization as part of process controller logic for all flowmeter inputs to the process controller. Display the totalized flows along with the instantaneous flow rate for each flowmeter at the HMI. Provide a password protected totalizer reset for all totalizers to allow reset to zero from the HMI by City staff having appropriate HMI security access.

S. Provide PLC resident equipment runtime totalization for all new and existing equipment where Running status is monitored. Provide equipment start counter for all new and existing equipment where Running status is monitored. Provide individual HMI based reset commands for both run times and start counters for each piece of equipment.

T. Provide HMI resident maintenance switch for all analog field instrumentation provided under this Contract. When activated, maintenance switch shall retain the last valid state of the device in PLC logic to allow the field instrument to be taken off line, for calibration, or for other maintenance functions. Maintenance switch shall be cleared manually by the operator upon completion of the maintenance functions. Provide a user adjustable maintenance switch timer that will automatically re-establish normal PLC

control monitoring after time out. Timer shall be user adjustable (0-4 hours, initially set at 30 minutes) and have the ability to be reset back to the maximum time duration when reactivated by the operator at any time during the time out period.

U. Monitor PLC condition and CPU, power supplies, I/O points, and other components using integral PLC diagnostics. Develop PLC specific HMI monitoring graphics for PLC component conditions.

V. Monitor the health of communication links for all SCADA server to PLC communications and PLC-to-PLC communications. Upon failure of a communication link, issue a respective communication link failure alarm at the HMI. Provide similar heartbeat scheme for monitoring health between PLC and HMI, PLC and vendor PLCs, and for all other network links shown on the Drawings.

W. PLC-to-PLC communications shall be limited to data that is required for controls and interlocks. PLC-to-PLC communications shall be programmed as follows:

1. The PLC that requires the data for control shall initiate the data read request from the remote PLC. PLCs shall not write data into another PLC's memory.

2. Data that is required by remote PLCs shall be packed into contiguous data arrays that can be read from a single read request by the remote PLCs. These data arrays shall include a minimum of 50% allocated spare memory capacity for all data types included in the array.

3. Data arrays that are read by remote PLCs shall include a heartbeat integer register. The heartbeat register shall continuously count from 0 to 9999 and then roll over back to zero. If the remote PLC detects that the heartbeat register stops changing, the remote PLC shall generate a PLC-to-PLC heartbeat failure alarm that is annunciated at the HMI.

4. PLC-to-PLC data transfers shall be optimized and timed by the PCSI to provide sufficient data update frequency to maintain smooth process control without burdening the Ethernet network with unnecessary traffic.

X. Provide password protection at the HMI, PLC, and communication network interfaces and control access to the respective devices in conformance with City security requirements. Coordinate password selection and implementation with the City.

Y. Transfer shared data using the communication networking interfaces between PLCs and other equipment platforms using block/array transfers only conforming to existing City programming standards.

1. SCADA system monitoring of process control variables via Modbus TCP network links shall include:

a. Geared Single Stage Centrifugal Blower Packages (Section 11502)

b. Biosolids Dryer System (Section 11600)

c. Aeration Control System (Section 13550)

d. Standby Diesel Engine Driven Generators (Section 16230)

e. Adjustable Speed Drives (ASDs) (Section 16260)

f. Power Metering Devices (Section 16290)

g. Medium Voltage Switchgear (Section 16350)

h. 480 Volt Switchgear (Section 16436)

i. Motor Control Centers (Section 16442)

2. SCADA system monitoring of process control variables via serial Modbus RTU (RS-485) shall include the following based on the first named manufacturer listed in the indicated Section. Refer to the Drawings for I/O monitoring if alternative equipment is provided:

   a. Submersible Compact Mixers (Section 11205)

   b. Submersible Low Speed Mixers (Section 11206)

3. Specific process control variables/parameters to be monitored via the network interfaces shall be as specified in these related sections. Process control data acquired via the network links shall be polled between devices and HMI, processed in an identical fashion as traditional I/O. Variables shall be arranged in contiguous registers for polling efficiency.

4. Network or serial link updates shall be based on a minimum polling/update time of 2 seconds between each device with HMI polling rates set at approximately 5 seconds.

5. Specific variables/parameters to be monitored via the network interfaces shall be provided to the PCSI at the first project coordination meeting as specified in Section 13400. Provide means for transferring a minimum of ten (10) asset management related analog variables from each system (e.g., each ASD, power metering device, etc.). Variables shall be arranged in contiguous registers for polling efficiency. Data acquired via the network links shall be polled between devices and HMI, processed in an identical fashion as traditional I/O except that network link updates shall be performed based on an operator adjustable time cycle initially set for once per hour with a hard coded minimum polling/update time of 60 seconds. Asset management variables need not be displayed on the HMI process control graphics but provide data display screens (text based) for each data source device to verify data monitoring activity.

END OF SECTION

APPENDIX 13482-A

PROCESS CONTROL DESCRIPTIONS

1. GENERAL

A. General

1. Descriptions refer to locations of alarm and control elements. Refer to I/O list for specific termination points of field sensors, switches, and panel lights.

2. Unless noted otherwise all panel mounted lights, control stations, indicators, and signal selectors shall be driven from resident PLC outputs and feed to resident PLC inputs.

3. Tag names within the Detailed Loop Specific Control Descriptions that refer to variables specific to that loop have been abbreviated to show only the instrumentation functional code and suffix. Complete tag names shall include the area code prefix and loop number. For example, the HMI based Local-Off-Remote selector switch for the Oxidation Ditch Wall Pump 1-1 (Loop 21-E17 on Drawing 21-I-01) is shown as HS-1. The complete tag name is 21-HS-E17-1.

4. Detailed Loop Specific Control Descriptions should be used in conjunction with the project P&ID Drawings and electrical schematic diagrams. Abbreviations and conventions used throughout are shown on Drawings GI-1 through GI-4.

2. CONTROL LOOP INDEX

P&ID	PN-PL LN	Description
I-20	52-O91[1]	Dryer Bldg Ventilation Exhaust Fan 52-F-11-A
I-20	52-O92[1]	Dryer Bldg Ventilation Exhaust Fan 52-F-12-A
I-20	52-O93[1]	Dryer Bldg Ventilation Exhaust Fan 52-F-13-A
I-20	52-O94[1]	Dryer Bldg Ventilation Exhaust Fan 52-F-14-A
I-20	52-O95[1]	Dryer Bldg Ventilation Exhaust Fan 52-F-15-A
I-20	27-E91	Maintenance Room Ventilation Exhaust Fan 27-F-01-A
I-20	27-E92	Maintenance Room Ventilation Exhaust Fan 27-F-02-A
I-20	36-H91	RAS PS Foul Air Supply Fan 36-F-01-FA
I-20	15-U52M	MVSG1, Main CB (15-BKR-52-M)
I-20	15-U52N	MVSG1, Xfmr N CB (15-BKR-52-N)
I-20	15-U52S	MVSG1, Xfmr S CB (15-BKR-52-S)
I-20	15-U52X	MVSG1, Spare CB (15-BKR-52-X)
I-20	15-U52A	SWGR-D, A Bus Main CB (15-BKR-AMAIN)
I-20	15-U52B	SWGR-D, B Bus Main CB (15-BKR-BMAIN)
I-20	15-U52T	SWGR-D, Tie CB (15-BKR-TIE)
I-20	15-U52A1	SWGR-D, Feeder A1 CB (15-BKR-A1)
I-20	15-U52A2	SWGR-D, Feeder A2 CB (15-BKR-A2)
I-20	15-U52A3	SWGR-D, Feeder A3 CB (15-BKR-A3)
I-20	15-U52A4	SWGR-D, Feeder A4 CB (15-BKR-A4)
I-20	15-U52B1	SWGR-D, Feeder B1 CB (15-BKR-B1)
I-20	15-U52B2	SWGR-D, Feeder B2 CB (15-BKR-B2)
I-20	15-U52B3	SWGR-D, Feeder B3 CB (15-BKR-B3)
I-20	52-O99[1]	Dryer Building UPS (52-UPS-D1U)
I-20	27-E99	Blower Building UPS (27-UPS-D2U)
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I-21	15-U91	Standby Generator (15-GEN-2)
I-21	15-U92	Transformer North (15-XFMR-N)
I-21	15-U93	Transformer South (15-XFMR-S)
I-21	15-U94	Station Batteries (15-BAT-1)
1-21	15-U95	Power Meters
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14-I-01	14-P50[1]	Dewatered Sludge Conveyor 1
14-I-01	14-P52[1]	Dewatered Sludge Conveyor 1 Slide Gate 1

P&ID	PN-PL LN	Description
14-I-01	14-P54[1]	Dewatered Sludge Conveyor 1 Slide Gate 2
14-I-01	14-P55[1]	Dewatered Sludge Conveyor 2
14-I-01	14-P57[1]	Dewatered Sludge Conveyor 2 Slide Gate 1
14-I-01	14-P59[1]	Dewatered Sludge Conveyor 2 Slide Gate 2
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14-I-02	14-P60[1]	Dewatered Sludge Conveyor 3
14-I-02	14-P65[1]	Dewatered Sludge Conveyor 4
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21-I-01	21-E10-1	Oxidation Ditch 1, Oxic Zone 1E Dissolved Oxygen Analyzer (21-AE/AIT-E10-1)
21-I-01	21-E10-2	Oxidation Ditch 1, Oxic Zone 1F Dissolved Oxygen Analyzer (21-AE/AIT-E10-2)
21-I-01	21-E10-3	Oxidation Ditch 1, Oxic Zone 1G Dissolved Oxygen Analyzer (21-AE/AIT-E10-3)
21-I-01	21-E10-4	Oxidation Ditch 1, Oxic Zone 1H Dissolved Oxygen Analyzer (21-AE/AIT-E10-4)
21-I-01	21-E10-5	Oxidation Ditch 1, Oxic Zone 1H Ammonia Analyzer (21-AE/AIT-E10-5)
21-I-01	21-E11	Oxidation Ditch 1 Mixer 1-1 (21-ME-01-ML)
21-I-01	21-E12	Oxidation Ditch 1 Mixer 1-2 (21-ME-02-ML)
21-I-01	21-E13	Oxidation Ditch 1 Mixer 1-3 (21-ME-03-ML)
21-I-01	21-E14	Oxidation Ditch 1 Mixer 1-4 (21-ME-04-ML)
21-I-01	21-E15	Oxidation Ditch 1 Mixer 1-5 (21-ME-05-ML)
21-I-01	21-E16	Oxidation Ditch 1 Mixer 1-6 (21-ME-06-ML)
21-I-01	21-E17	Oxidation Ditch Wall Pump 1-1 (21-P-04-ML)
21-I-01	21-E18	Oxidation Ditch Wall Pump 1-2 (21-P-05-ML)
21-I-01	21-E19	Oxidation Ditch Mixer 1-7 (21-ME-07-ML)
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21-I-02	21-E20	Oxidation Ditch 1 Oxic Zone 1E Air Flow (21-E20)
21-I-02	21-E21	Oxidation Ditch 1 Oxic Zone 1F Air Flow (21-E21)
21-I-02	21-E22	Oxidation Ditch 1 Oxic Zone 1G Air Flow (21-E22)
21-I-02	21-E23	Oxidation Ditch 1 Oxic Zone 1H Air Flow (21-E23)
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22-I-01	22-E10-1	Oxidation Ditch 2, Oxic Zone 2E Dissolved Oxygen Analyzer (22-AE/AIT-E10-1)
22-I-01	22-E10-2	Oxidation Ditch 2, Oxic Zone 2F Dissolved Oxygen Analyzer (22-AE/AIT-E10-2)
22-I-01	22-E10-3	Oxidation Ditch 2, Oxic Zone 2G Dissolved Oxygen Analyzer (22-AE/AIT-E10-3)
22-I-01	22-E10-4	Oxidation Ditch 2, Oxic Zone 2H Dissolved Oxygen Analyzer (22-AE/AIT-E10-4)

P&ID	PN-PL LN	Description
22-I-01	22-E10-5	Oxidation Ditch 2, Oxic Zone 2H Ammonia Analyzer (22-AE/AIT-E10-5)
22-I-01	22-E11	Oxidation Ditch 2 Mixer 2-1 (22-ME-01-ML)
22-I-01	22-E12	Oxidation Ditch 2 Mixer 2-2 (22-ME-02-ML)
22-I-01	22-E13	Oxidation Ditch 2 Mixer 2-3 (22-ME-03-ML)
22-I-01	22-E14	Oxidation Ditch 2 Mixer 2-4 (22-ME-04-ML)
22-I-01	22-E15	Oxidation Ditch 2 Mixer 2-5 (22-ME-05-ML)
22-I-01	22-E16	Oxidation Ditch 2 Mixer 2-6 (22-ME-06-ML)
22-I-01	22-E17	Oxidation Ditch Wall Pump 2-1 (22-P-04-ML)
22-I-01	22-E18	Oxidation Ditch Wall Pump 2-2 (22-P-05-ML)
22-I-01	22-E19	Oxidation Ditch Mixer 2-7 (22-ME-07-ML)
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22-I-01	22-E20	Oxidation Ditch 2 Oxic Zone 2E Air Flow (22-E20)
22-I-01	22-E22	Oxidation Ditch 2 Oxic Zone 2F Air Flow (22-E21)
22-I-01	22-E22	Oxidation Ditch 2 Oxic Zone 2G Air Flow (22-E22)
22-I-01	22-E23	Oxidation Ditch 2 Oxic Zone 2H Air Flow (22-E23)
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23-I-01	23-E1	Aeration Basin 3 Mixer 3-1 (23-ME-01-ML)
23-I-01	23-E2	Aeration Basin 3 Mixer 3-2 (23-ME-02-ML)
23-I-01	23-E3	Aeration Basin 3 Mixer 3-3 (23-ME-03-ML)
23-I-01	23-E4	Aeration Basin 3 Mixer 3-4 (23-ME-04-ML)
23-I-01	23-E5	Aeration Basin 3 Wall Pump 3-1 (23-P-01-ML)
23-I-01	23-E6	Aeration Basin 3 Mixer 3-5 (23-ME-05-ML)
23-I-01	23-E10-1	Aeration Basin 3, Oxic Zone 3E Dissolved Oxygen Analyzer (23-AE/AIT-E10-1)
23-I-01	23-E10-2	Aeration Basin 3, Oxic Zone 3F Dissolved Oxygen Analyzer (23-AE/AIT-E10-2)
23-I-01	23-E10-3	Aeration Basin 3, Oxic Zone 3G Dissolved Oxygen Analyzer (23-AE/AIT-E10-3)
23-I-01	23-E10-4	Aeration Basin 3, Oxic Zone 3H Dissolved Oxygen Analyzer (23-AE/AIT-E10-4)
23-I-01	23-E10-5	Aeration Basin 3, Oxic Zone 3H Ammonia Analyzer (23-AE/AIT-E10-5)
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23-I-02	23-E20	Aeration Basin 3 Oxic Zone 3E Air Flow (23-E20)
23-I-02	23-E21	Aeration Basin 3 Oxic Zone 3F Air Flow (23-E21)
23-I-02	23-E22	Aeration Basin 3 Oxic Zone 3G Air Flow (23-E22)
23-I-02	23-E23	Aeration Basin 3 Oxic Zone 3H Air Flow (23-E23)
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P&ID	PN-PL LN	Description
24-I-01	24-E1	Aeration Basin 4 Mixers 4-1 (24-ME-01-ML)
24-I-01	24-E2	Aeration Basin 4 Mixers 4-2 (24-ME-02-ML)
24-I-01	24-E3	Aeration Basin 4 Mixers 4-3 (24-ME-03-ML)
24-I-01	24-E4	Aeration Basin 4 Mixers 4-4 (24-ME-04-ML)
24-I-01	24-E5	Aeration Basin 4 Wall Pump 4-1 (24-P-01-ML)
24-I-01	24-E6	Aeration Basin 4 Mixer 4-5 (24-ME-05-ML)
24-I-01	24-E10-1	Aeration Basin 4, Oxic Zone 4E Dissolved Oxygen Analyzer (243-AE/AIT-E10-1)
24-I-01	24-E10-2	Aeration Basin 4, Oxic Zone 4F Dissolved Oxygen Analyzer (24-AE/AIT-E10-2)
24-I-01	24-E10-3	Aeration Basin 4, Oxic Zone 4G Dissolved Oxygen Analyzer (24-AE/AIT-E10-3)
24-I-01	24-E10-4	Aeration Basin 4, Oxic Zone 4H Dissolved Oxygen Analyzer (24-AE/AIT-E10-4)
24-I-01	24-E10-5	Aeration Basin 4, Oxic Zone 4H Ammonia Analyzer (24-AE/AIT-E10-5)
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24-I-02	24-E10	Aeration Basin 4 Oxic Zone 4E Air Flow
24-I-02	24-E11	Aeration Basin 4 Oxic Zone 4F Air Flow
24-I-02	24-E12	Aeration Basin 4 Oxic Zone 4G Air Flow
24-I-02	24-E13	Aeration Basin 4 Oxic Zone 4H Air Flow
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27-I-01	24-E10	Blower 1 (27-B-01-AA)
27-I-01	24-E11	Blower 1 Inlet Filter Differential Pressure Transmitter (27-PDT-E11)
27-I-01	24-E12	Blower 1 Inlet Temperature Transmitter (27-TIT-12) and Pressure Switch (27-PSH-12)
27-I-01	24-E13	Blower 1 Inlet Valve (27-V-11-AA)
27-I-01	24-E14	Blower 1 Discharge Valve (27-V-12-AA)
27-I-01	24-E15	Blower 1 Differential Pressure Transmitter (27-PDT-15)
27-I-01	24-E17	Blower 1 Effluent Temperature Transmitter (27-TT-17)
27-I-01	24-E18	Blower 1 Blow-Off Valve (27-V-13-AA)
27-I-01	24-E19	Blower 1 System Discharge Valve (27-V-14-AA)
27-I-01	24-E20	Blower 2 (27-B-02-AA)
27-I-01	24-E21	Blower 2 Inlet Filter Differential Pressure Transmitter (27-PDT-E21)
27-I-01	24-E22	Blower 2 Inlet Temperature Transmitter (27-TIT-22) and Pressure Switch (27-PSH-22)
27-I-01	24-E23	Blower 2 Inlet Valve (27-V-21-AA)
27-I-01	24-E24	Blower 2 Discharge Valve (27-V-22-AA)
27-I-01	24-E25	Blower 2 Differential Pressure Transmitter (27-PDT-25)

P&ID	PN-PL LN	Description
27-I-01	24-E27	Blower 2 Effluent Temperature Transmitter (27-TT-27)
27-I-01	24-E28	Blower 2 Blow-Off Valve (27-V-23-AA)
27-I-01	24-E29	Blower 2 System Discharge Valve (27-V-24-AA)
--	--	--
27-I-02	24-E30	Blower 3 (27-B-03-AA)
27-I-02	24-E31	Blower 3 Inlet Filter Differential Pressure Transmitter (27-PDT-E31)
27-I-02	24-E32	Blower 3 Inlet Temperature Transmitter (27-TIT-32) and Pressure Switch (27-PSH-32)
27-I-02	24-E33	Blower 3 Inlet Valve (27-V-31-AA)
27-I-02	24-E34	Blower 3 Discharge Valve (27-V-32-AA)
27-I-02	24-E35	Blower 3 Differential Pressure Transmitter (27-PDT-35)
27-I-02	24-E37	Blower 3 Effluent Temperature Transmitter (27-TT-37)
27-I-02	24-E38	Blower 3 Blow-Off Valve (27-V-33-AA)
27-I-02	24-E39	Blower 3 System Discharge Valve (27-V-34-AA)
27-I-02	24-E40	Blower 4 (27-B-04-AA)
27-I-02	24-E41	Blower 4 Inlet Filter Differential Pressure Transmitter (27-PDT-E41)
27-I-02	24-E42	Blower 4 Inlet Temperature Transmitter (27-TIT-42) and Pressure Switch (27-PSH-42)
27-I-02	24-E43	Blower 4 Inlet Valve (27-V-41-AA)
27-I-02	24-E44	Blower 4 Discharge Valve (27-V-42-AA)
27-I-02	24-E45	Blower 4 Differential Pressure Transmitter (27-PDT-45)
27-I-02	24-E47	Blower 4 Effluent Temperature Transmitter (27-TT-47)
27-I-02	24-E48	Blower 4 Blow-Off Valve (27-V-43-AA)
27-I-02	24-E49	Blower 4 System Discharge Valve (27-V-44-AA)
--	--	--
34-I-01	34-G1	Secondary Clarifier 3
--	--	--
36-I-01	36-H2	RAS Pump 5 (36-P-02-RAS)
36-I-01	36-H3	RAS Pump 6 (36-P-03-RAS)
36-I-01	36-H4	RAS Pump Station Inlet Flowmeter
--	--	--
36-I-02	36-H5	Scum Pit Mixing Blower (36-B-01-FA)
36-I-02	36-H6	Scum Pit Level Switches (36-LSXX-H6)
36-I-02	36-H7	Secondary Scum Pump 3 (36-P-01-S)
36-I-02	36-H8	Secondary Scum Pump 4 (36-P-02-S)
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P&ID	PN-PL LN	Description
36-I-03	36-H11	RAS Pump Station Sump Level Switches (36-LSXX-H11)
36-I-03	36-H12	RAS Pump Station Sump Pump 3 (36-P-01-PD)
36-I-03	36-H13	RAS Pump Station Sump Pump 4 (36-P-02-PD)
--	--	--
50-I-01	50-J10	Filter Loading Flowmeter
50-I-01	50-J12	Ammonia Analyzer
--	--	--
51-I-01	51-N1	WAS Storage Flowmeter and Solids Analyzer (51-FE/FIT-N1 and 51-AE/AIT-N1)
51-I-01	51-N2	WAS Storage Tank 1 Inlet Valve (51-V-01-WAS)
51-I-01	51-N3	WAS Storage Tank 2 Inlet Valve (51-V-02-WAS)
51-I-01	51-N4	WAS Storage Tank 3 Inlet Valve (51-V-03-WAS)
51-I-01	51-N5	WAS Storage Mixing Blower 1 (51-B-01-AA)
51-I-01	51-N6	WAS Storage Mixing Blower 2 (51-B-02-AA)
51-I-01	51-N7	Storage Tank 1 Air Flow (51-N7)
51-I-01	51-N8	Storage Tank 2 Air Flow (51-N8)
51-I-01	51-N9	Storage Tank 3 Air Flow (51-N9)
51-I-01	51-N11	WAS Storage Tank 1 Decant Effluent Valve 1 (51-V-01-DEC)
51-I-01	51-N12	WAS Storage Tank 1 Decant Effluent Valve 2 (51-V-02-DEC)
51-I-01	51-N13	WAS Storage Tank 1 Decant Effluent Valve 3 (51-V-03-DEC)
51-I-01	51-N14	WAS Storage Tank 2 Decant Effluent Valve 1 (51-V-04-DEC)
51-I-01	51-N15	WAS Storage Tank 2 Decant Effluent Valve 2 (51-V-05-DEC)
51-I-01	51-N16	WAS Storage Tank 2 Decant Effluent Valve 3 (51-V-06-DEC)
51-I-01	51-N17	WAS Storage Tank 3 Decant Effluent Valve 1 (51-V-07-DEC)
51-I-01	51-N18	WAS Storage Tank 3 Decant Effluent Valve 2 (51-V-08-DEC)
51-I-01	51-N19	WAS Storage Tank 3 Decant Effluent Valve 3 (51-V-09-DEC)
51-I-01	51-N20	WAS Storage Tank 1 WAS Effluent Valve (51-V-04-WAS)
51-I-01	51-N21	WAS Storage Tank 2 WAS Effluent Valve (51-V-05-WAS)
51-I-01	51-N22	WAS Storage Tank 3 WAS Effluent Valve (51-V-06-WAS)
51-I-01	51-N23	WAS Storage Tanks Influent Valve (51-V-08-WAS)
51-I-01	51-N24	WAS Storage Tanks Influent Valve (51-V-09-WAS)
51-I-01	51-N25	Storage Tank 1 Level Sensor (51-LE/LIT-N25)
51-I-01	51-N26	Storage Tank 2 Level Sensor (51-LE/LIT-N26)

P&ID	PN-PL LN	Description
51-I-01	51-N27	Storage Tank 3 Level Sensor (51-LE/LIT-N27)
51-I-01	51-N28	WAS Storage Suspended Solids Analyzer (51-AE/AIT-N28)
51-I-01	51-N29	WAS Storage Tanks Drain Valve (51-V-01-D)
--	--	--
52-I-01	52-O10 thru 52-O19[1]	Dewatered Cake Feed System
--	--	
52-I-02	52-O20 thru 52-O29[1]	Paddle Dryer and Discharge Conveyor
--	--	
52-I-03	52-O30 thru 52-039[1]	Dried Product Handling System
--	--	
52-I-04	52-O40 thru 52-O49[1]	Dried Solids Load Out System
--	--	
52-I-05	52-O50 thru 52-059[1]	Dryer Off-Gas Handling System
--	--	
52-I-06	52-O60 thru O68[1]	Dried Solids Load Out System
52-I-06	52-O69[1]	Plant Gas Flowmeter (52-FE/FIT-O69)
--	--	
52-I-07	52-O70 thru 52-O77[1]	Compressed Air and Utility Water System
52-I-07	52-078[1]	Plant Utility Water Flowmeter (52-FE/FIT-O78)
52-I-07	52-079[1]	Plant Utility Water Low Pressure Switch (52-PSL-O79)
52-I-07	52-079[1]	Sprayer Water and Off Gas Compressor Utility Water Control Solenoid Valve (52-SV-20-CA)
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52-I-08	52-O80 thru 52-O89[1]	Dust Control Scrubber
--	--	
52-I-09	52-O27[1]	Paddle Spray Water Scrubber
--	--	
60-I-01	60-K2	Existing Flowmeter at Chlorine Contact Basins

P&ID	PN-PL LN	Description
		(60-FE/FIT-K2)
60-I-01	60-K4-2	Chlorine Contact Basins Effluent Free Chlorine Analyzer (60-AE/AIT-K4-2)
60-I-01	60-K4-3	Chlorine Contact Basins Channels Free Chlorine Analyzer (60-AE/AIT-K4-3)
60-I-01	60-K10	Chlorine Contact Basins Free Chlorine Analyzer (60-AE/AIT-K10)
60-I-01	60-K10	Chlorine Contact Basins Free Chlorine Analyzer Sample Pump Flow (60-FSH-K10)
60-I-01	60-K12	Chlorine Contact Basin 2 Influent Gate (62-G-05-FEF)
60-I-01	60-K14	Chlorine Contact Basin 2 Influent Gate (62-G-06-FEF)
60-I-01	60-K16	Chlorine Contact Basin 2 Reduced Channel Effluent Gate (62-G-03-FE)
60-I-01	60-K18	Chlorine Contact Basin 1 Influent Gate (62-G-08-FEF)
60-I-01	60-K21	Chlorine Contact Basin 2 Effluent Sample Pump (62-P-06-SA)
60-I-01	60-K22	Chlorine Contact Basin 2 Channel Influent Sample Pump (62-P-07-SA)
60-I-01	60-K23	Chlorine Contact Basin 2 Channel Effluent Sample Pump (62-P-08-SA)
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61-I-01	61-I3	Filter Feed Pump 3 (61-P-03-SE)
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Notes:

1. Work is included as part of Schedules C, D and E and shall not be performed if those Schedules are not selected. Refer to Specification Section 01025 – Measurement and Payment for additional detail on Bid Schedules.

3. DETAILED LOOP SPECIFIC CONTROL DESCRIPTIONS

A. Notes:

1. Use of the term N/A (Not Applicable) indicates existing field level controls or monitoring devices that are included in the description for completeness but not included in the work performed under this Contract except for new monitoring circuits to new control panels or HMI as indicated on the Contract Documents.

2. Descriptions refer to locations of alarm and control elements. Refer to I/O list for specific termination points of field sensors, switches, and panel lights.

3. Unless noted otherwise all panel mounted lights, control stations, indicators, and signal selectors shall be driven from resident PLC outputs and feed to resident PLC inputs.

LOOP 52-O91

Dryer Bldg Ventilation Exhaust Fan 52-F-11-A

P&ID: I-20

Description:

There are five exhaust fans for the Dryer Building. Fans are on controlled via thermostat to provide cooling. Fans are allocated as follows:

DRYER BUILDING FAN LOCATION	DRYER BUILDING FAN HVAC ID	DRYER BUILDING FAN P&ID TAG/LOOP NUMBER
THERMAL ROOM	EF-1	52-F-11-A / O91
MAIN DRYER BUILDING	EF-2	52-F-12-A / O92
MAIN DRYER BUILDING	EF-3	52-F-13-A / O93
MAIN DRYER BUILDING	EF-4	52-F-14-A / O94
MAIN DRYER BUILDING	EF-5	52-F-15-A / O95

Control:

Field:

None

Local (Fan Starter Panel):

Local thermostat. Refer to HVAC Drawings

Remote (HMI at SCADA Central):

None

Power Failure State

Automatic restart after restoration of power

Alarms and Monitoring:

Field:

None

Local (Fan Starter Panel):

Status:

Running

Alarm:

None

Remote (HMI at SCADA Central)

Status:

Running (YS)

Alarm:

None

LOOP 52-O92

Dryer Bldg Ventilation Exhaust Fan 52-F-12-A

P&ID: I-20

Functionally equivalent to Loop 52-O91

LOOP 52-O93

Dryer Bldg Ventilation Exhaust Fan 52-F-13-A

P&ID: I-20

Functionally equivalent to Loop 52-O91

LOOP 52-O94

Dryer Bldg Ventilation Exhaust Fan 52-F-14-A

P&ID: I-20

Functionally equivalent to Loop 52-O91

LOOP 52-O95

Dryer Bldg Ventilation Exhaust Fan 52-F-15-A

P&ID: I-20

Functionally equivalent to Loop 52-O91

LOOP 27-E91

Blower Bldg/Maintenance Room Ventilation Exhaust Fan 27-F-01-A

P&ID: I-20

Description:

There are two exhaust fans for the Maintenance Room. Fans are on controlled via thermostat to provide cooling. Fans are allocated as follows:

BLOWER BUILDING FAN LOCATION	DRYER BUILDING FAN HVAC ID	DRYER BUILDING FAN P&ID TAG/LOOP NUMBER
MAINTENANCE ROOM	EF-1	27-F-01-A / E91
MAINTENANCE ROOM	EF-2	27-F-02-A / E91

Control:

Field:

None

Local (MCC D2A):

Local thermostat. Refer to HVAC Drawings

Remote (HMI at SCADA Central):

None

Power Failure State

Automatic restart after restoration of power

Alarms and Monitoring:

Field (MCC D2A):

Status:

Running

Alarm:

None

Remote (HMI at SCADA Central)

Status:

Running (YS)

Alarm:

None

LOOP 27-E92

Maintenance Room Ventilation Exhaust Fan 27-F-02-A

P&ID: I-20

Functionally equivalent to Loop 52-E91

LOOP 36-H91

RAS PS Foul Air Supply Fan 36-F-01-FA

P&ID: I-20

Description:

There is one exhaust fan for the RAS pump station. The fan runs continuously with an ON/OFF switch. Fan ventilation is used to declassify the RAS pump station from a Class 1 Division 2 location.

Control:

Field:

None

Local (MCC D3B):

On/Off

Remote (HMI at SCADA Central):

None

Power Failure State

Automatic restart after restoration of power

Alarms and Monitoring:

Field:

None

Local (MCC D3B):

Status:

Running

Alarm:

None

Remote (HMI at SCADA Central)

Status:

Running (YS)

Alarm:

Not Running (YA)

LOOP 15-U52M

MVSG1, Main CB (15-BKR-52-M)

P&ID: I-20

Description:

MVSG-1 is a 21 kV metal enclosed switchgear used to distribute power for the existing, new or modified process loads provided under this Project. Circuit breakers located within the

Switchgear are monitored for position and status by Plant SCADA.

Power system parameters shall be monitored with a combination of hard I/O, dedicated power system protection networks, and network based interfaces to the SCADA System. Systems to be monitored include:

- Medium Voltage Switchgear (Section 16350)
- 480 Volt Switchgear (Section 16436)

Circuit breaker status shall be available from SCADA as defined below. Full monitoring capability from distribution equipment for diagnostics and asset management shall be provided as specified under Paragraph 3.2.

Power system protection schemes for differential and zone selective protection (Section 16350 and 16436) shall be implemented on dedicated networks separate from the PCS process control network(s). Remote manual operation of power system devices (switchgear circuit breakers) shall be provided with the switchgear equipment as specified. Control of power distribution equipment via SCADA is not required.

Control:

Field:

N/A

Local (MVSG1):

Provides full operating control and protection capability for the switchgear. Provided as a packaged system provided by the switchgear system supplier under Section 16350.

Remote (HMI at SCADA Central):

None

Power Failure State:

Equipment remains in continuous operational via station batteries or UPS

Alarms and Monitoring:

Field:

N/A

Local (MVSG1):

Provides full monitoring capability of the switchgear. Provided as a packaged system provided by the switchgear system supplier under Section 16350

Remote (HMI at SCADA Central)

Breaker Status Opened (ZSO)
Breaker Status Closed (ZSC)
Breaker Status Trip (XA)

LOOP 15-U52B

MVSG1, Xfmr N CB (15-BKR-52-N)

P&ID: I-20

Functionally equivalent to Loop 15-U52M

LOOP 15-U52S

MVSG1, Xfmr S CB (15-BKR-52-N)

P&ID: I-20

Functionally equivalent to Loop 15-U52M

LOOP 15-U52X

MVSG1, SPARE CB (15-BKR-52-N)

P&ID: I-20

Functionally equivalent to Loop 15-U52M

LOOP 15-U52A

SWGR-D, A Bus Main CB (15-BKR-AMAIN)

P&ID: I-20

Functionally equivalent to Loop 15-U52M

LOOP 15-U52B

SWGR-D, B Bus Main CB (15-BKR-BMAIN)

P&ID: I-20

Functionally equivalent to Loop 15-U52M

LOOP 15-U52T

SWGR-D, Tie CB (15-BKR-TIE)

P&ID: I-20

Functionally equivalent to Loop 15-U52M

LOOP 15-U52A1

SWGR-D, Feeder A1 (15-BKR-A1)

P&ID: I-20

Functionally equivalent to Loop 15-U52M

LOOP 15-U52A2

SWGR-D, Feeder A2 (15-BKR-A2)

P&ID: I-20

Functionally equivalent to Loop 15-U52M

LOOP 15-U52A3

SWGR-D, Feeder A3 (15-BKR-A3)

P&ID: I-20

Functionally equivalent to Loop 15-U52M

LOOP 15-U52A4

SWGR-D, Feeder A4 (15-BKR-A4)

P&ID: I-20

Functionally equivalent to Loop 15-U52A4

LOOP 15-U52B1

SWGR-D, Feeder B1 (15-BKR-B1)

P&ID: I-20

Functionally equivalent to Loop 15-U52M

LOOP 15-U52B2

SWGR-D, Feeder B2 (15-BKR-B2)

P&ID: I-20

Functionally equivalent to Loop 15-U52M

LOOP 15-U52B3

SWGR-D, Feeder B3 (15-BKR-B3)

P&ID: I-20

Functionally equivalent to Loop 15-U52M

LOOP 52-O99

Dryer Building UPS (52-UPS-D1U)

P&ID: I-20

Description:

52-UPS-D1U (Loop 52-O99) provides backup, emergency power to critical process monitoring and control system loads for equipment located in and around the Dryer Building. UPS operating parameters are monitored for alarm status.

Control:

Field:

None

Local (UPS):

None

Remote (HMI at SCADA Central):

None

Power Failure State:

N/A: UPS provides continuous power during power outage

Alarms and Monitoring:

Field:

None

Local (UPS):

Provides full monitoring capability of the UPS from the UPS panel interface display. Provided as a packaged system provided by the UPS suppler under Section 16263

Remote (HMI at SCADA Central)

Alarms:

UPS On Inverter (YS-A)
UPS In Bypass (YS-B)
UPS On Battery (YS-C)
UPS On Converter (YS-D)
UPS Battery Low Voltage (EAL)
UPS Overload (JAH)
UPS Fail (UA)

Status:

UPS Converter Operating (YS-H)

LOOP 27-E99

Blower Building UPS (27-UPS-D2U)

P&ID: I-20

Functionally equivalent to Loop 52-O99

LOOP 15-U91

Standby Generator (15-GEN-2)

P&ID: I-21

Description:

15-GEN-2 (Loop U91) provides standby power to process, lighting and ancillary loads at the WWTP as defined under Section 16230. Generator operating parameters are monitored for alarm status.

Control:

Field:

None

Local (Generator):

None

Remote (HMI at SCADA Central):

None

Power Failure State

N/A: Generator provides continuous power during power outage

Alarms and Monitoring:

Field:

None

Local (Generator):

Provides full monitoring capability of the generator. Provided as a packaged system provided by the generator system supplier under Section 16230

Remote (HMI at SCADA Central)

Alarms:

Generator Fuel Tank Low Level (LAL)

Generator Overcrank (KAH)

Generator Over Speed (SAH)

Generator Oil High Temperature (TAH-A)

Generator Hot (TAH-B)

Generator Overload (JAH)

Status:

Generator Running (YS)

LOOP 15-U92

Transformer North (15-XFMR-N)

P&ID: I-21

Description:

S-4A includes a 21kV – 480 V step-down transformer. Transformer operating parameters are monitored for alarm status.

Control:

Field:

None

Local:

None

Remote (HMI at SCADA Central):

None

Power Failure State

N/A

Alarms and Monitoring:

Field:

Local pressure and level gages provided with transformers under Section 16271

Local:

None

Remote (HMI at SCADA Central)

Transformer Fill Level Low (LAL)
Transformer Over Pressure Relay (PAH)
Transformer High Temperature (TAH)

LOOP 15-U93

Transformer South (15-XFMR-S)

P&ID: I-21

Functionally equivalent to Loop 15-U92

LOOP 15-U94

Station Batteries (15-BAT-1)

P&ID: I-21

Description:

Station batteries are provided with MVSG-1 for DC control power to protection relays and breaker operating mechanisms. Station Battery operating parameters are monitored for alarm status.

Control:

Field:

None

Local:

None

Remote (HMI at SCADA Central):

None

Power Failure State

N/A

Alarms and Monitoring:

Field:

None

Local (14-LP-10):

Battery charger provides full monitoring capability of the batteries interface display. Provided as a packaged system provided by the station battery supplier under Section 16244

Remote (HMI at SCADA Central)

Battery Low Voltage (EAL)
System On Batteries (YA-B)
Fail (UA)

LOOP XX-U95-Y

Power Meters

P&ID: I-21

Description:

Provide load monitoring and power demand alert logic to inform operators of real-time power demand values for the facility. Provide summary screens presenting loads acquired from the power monitoring meters. Use circuit breaker position status (Loop U15U52#) and generator running status (Loop 15-U91 and existing generator status) to present plant operating condition (utility or generator power) and specific generator operation.

Compare complex power load on each generator with generator rated capacity. Provide an advisory status to the operators when a generator demand load exceeds a user defined setpoint (initially set at 80% of each generator capacity). Provide an advisory alarm condition to the operators when a generator demand load exceeds a user defined setpoint (initially set at 90% of each generator capacity. Plant operators shall be responsible for manually determining what process loads will remain operational and/or what loads will be removed from service.

Coordinate load monitoring and power demand alert logic and status with the SCADA System electrical distribution graphical screens.

Provide dedicated power monitoring screens for each meter location as follows:

METER LOCATION	LOOP #	LOCATION	PLC
MVSG1, FEEDER XFMR-S	U95-A	15 (MVSG1)	16-CP-02
MVSG1, FEEDER XFMR-N	U95-B	15 (MVSG1)	16-CP-02
MVSG1, FEEDER MAIN	U95-C	15 (MVSG1)	16-CP-02
SWGR A MAIN	U95-D	16 (SWGR-A)	16-CP-02
SWGR A, SWGR B FEEDER	U95-E	16 (SWGR A)	16-CP-02
SWGR C	U95-F	40 (SWGR C)	43-CP-01
SWGR D, A FEEDER	U95-G	15 (SWGR D)	16-CP-02
SWGR D, B FEEDER	U95-H	15 (SWGR D)	16-CP-02
DPD1	U95-I	52 (DPD1)	52-CP-01
DPD2, A FEEDER	U95-J	27 (DPD2)	27-CP-01
DPD2, B FEEDER	U95-K	27 (DPD2)	27-CP-01
MCC D3A	U95-L	24 (MCC D3)	34-CP-01
MCC D3B	U95-M	24 (MCC D3)	34-CP-01
MCC D1	U95-N	52 (MCC D1)	52-MCP-01

Control:

Field:

None

Local (XX-LP):

None

Remote (HMI at SCADA Central):

None

Power Failure State

None

Alarms and Monitoring:

Field:

Access to power monitoring variables from each power meter location

Local (See PLC location in table above):

None

Remote (HMI at SCADA Central)

Alarms

- Generator power 80% demand alarm at each meter (typical of two generators)
- Generator power 90% demand alarm at each meter (typical of two generators)

Status

- Derived plant operating condition (utility or generator)
- Power meter parameters (via Modbus TCP)
  - a) Phase Voltage (Volts)
  - b) Phase Current (Amps)
  - c) Real Power (kW)
  - d) Reactive power (kVAR)
  - e) Apparent Power (KVA)
  - f) Power Factor
  - g) Watt Hour
  - h) VAR Hour
  - i) Frequency (Hz)
  - j) Total harmonic voltage distortion
  - k) Total harmonic current distortion

Power Failure State

None

Loop Series 14:

Sludge Conveyors Operational Overview

Description:

Existing Sludge Conveyor 1 (14-ME-01-SL) and Sludge Conveyor 2 (14-ME-01-SL) shall be renovated and modified to convey dewatered sludge. Sludge Conveyor 1 shall be renamed as Dewatered Sludge Conveyor 1 (14-ME-01-DWS) and Sludge Conveyor 2 renamed as Dewatered Sludge Conveyor 2 (14-ME-02-DWS). Existing slide gates 14-G-01-DWS and 14-G3-DWS shall continue to route sludge to the existing sludge handling conveyors. However, new slide gates 14-G-02-DWS and 14-G-04-DWS shall be installed at the conveyors to route sludge to the Dryer System vis new Dewatered Sludge Conveyors 3 and 4 (Screw Conveyors 14-ME-03-DWS and 14-ME-04-DWS). New gate and conveyor controls in new panel 14-LP-10 and modifications to existing controls resident in panel 14-LP-03 shall be provided by the Conveyor System Supplier per Section 14552 and as shown on the Drawings.

The conveyor and gate systems are operated in a semi-automatic control scheme initiated by an operator and requires an operator to switch gates at 14-LP-04 (in the truck bay) to assure that the product is being conveyed to the proper trailer, correct gate configuration, and assure safety of the area. This semi-automatic control shall be extended to new and modified conveyors used to route sludge to the new Dryer Facility.

Revised conveyor system for dryers consists of four conveyors: two from revised belt presses, Conveyor Nos. 1 and 2 renamed XXX to reflect operation with dewatered sludge, and two new dewatered sludge screw conveyors Nos 3 and 4 that deliver the dewatered sludge to the Sludge Hopper. Pneumatically operated gates on Conveyors 1 and 2 (one existing and one new per conveyor) are open/closed to direct the sludge to either the existing Sludge Screw Conveyors and 4 or the new Dewatered Conveyors 3 and 4.

Under the existing system, the gate position selection is performed manually from control panel 14-LP-04 in the truck bay as part of system setup. This arrangement shall be retained for routing sludge to existing while new gates and conveyors controlled from the new panel 14-LP-10 provided by the Conveyor equipment supplier under Section 14552.

NEW AND EXISTING GATE TRUTH TABLE

Sludge Source	Equipment State	Slide Gate - State	Destination	Permissive States (Note 1 and Note 2)
TRAIN 1	Belt Filter Press 1 OFF and Dewatered Sludge Conveyor 1 OFF	ALL STATES	NOT APPLICABLE	PRESS 1 SETUP OK = FALSE DRYER SETUP OK = FALSE
	Belt Filter Press 1 RUNNING and Dewatered Sludge Conveyor 1 RUNNING	14-G-01-DWS – Closed 14-G-02-DWS - Closed	To Existing Dewatered Sludge Screw Conveyor (South Bay)	PRESS 1 SETUP OK = TRUE DRYER SETUP OK = FALSE
		14-G-01-DWS – Open 14-G-02-DWS - Closed	To Existing Dewatered Sludge Screw Conveyor (North Bay)	PRESS 1 SETUP OK = TRUE DRYER SETUP OK = FALSE
		14-G-01-DWS – Closed 14-G-02-DWS – Open	To Dewatered Sludge Conveyor 3 for Dryer Operation	PRESS 1 SETUP OK = FALSE DRYER SETUP OK = TRUE
		14-G-01-DWS – Open	To Existing Dewatered	PRESS 1 SETUP OK = TRUE

Sludge Source	Equipment State	Slide Gate - State	Destination	Permissive States (Note 1 and Note 2)
		14-G-02-DWS – Open	Sludge Screw Conveyor (North Bay	DRYER SETUP OK = FALSE
	Belt Filter Press 2 OFF and Dewatered Sludge Conveyor 2 OFF	ALL STATES	NOT APPLICABLE	PRESS 2 SETUP OK = FALSE DRYER SETUP OK = FALSE
TRAIN 2	Belt Filter Press 2 Running and Dewatered Sludge Conveyor 2 Running	14-G-03-DWS – Closed 14-G-04-DWS - Closed	To Existing Dewatered Sludge Screw Conveyor (North Bay)	PRESS 2 SETUP OK = TRUE DRYER SETUP OK = FALSE
		14-G-03-DWS – Open 14-G-04-DWS - Closed	To Existing Dewatered Sludge Screw Conveyor (South Bay)	PRESS 2 SETUP OK = TRUE DRYER SETUP OK = FALSE
		14-G-03-DWS – Closed 14-G-04-DWS – Open	To Dewatered Sludge Conveyor 3 for Dryer Operation	PRESS 2 SETUP OK = FALSE DRYER SETUP OK = TRUE
		14-G-03-DWS – Open 14-G-04-DWS – Open	To Existing Dewatered Sludge Screw Conveyor (South Bay)	PRESS 2 SETUP OK = TRUE DRYER SETUP OK = FALSE

Table Notes:

2. PRESS 1 SETUP OK and PRESS 2 SETUP OK are existing system variables. These variables shall be modified within the existing Panel 14-LP-03 PLC with existing logic modified as shown.

3. Provide new system variable DRYER SETUP OK as a new system output based on associated Conveyor and Gate States. Variable shall be transmitted to the Dryer System controller and Plant HMI for use by Operations.

4. On High sludge hopper (LSHH-O10) and DRYER HOPPER OK is TRUE, Set DRYER HOPPER OK to FALSE, shutdown associated conveyors configured for dryer supply and shutdown any associated belt filter presses in existing belt filter press logic.

The existing conveyor system PLC (Rockwell Automation SLC unit) located in Panel 14-LP-03 verifies that the setup is an allowed combination, and, if so, shall enable operation of the existing press system. PRESS 1 SETUP OK and PRESS 2 SETUP OK conditionals shall be modified per the Table above. An additional variable DRYER SETUP OK shall be provided and used as an advisory condition. The DRYER SETUP OK variable shall be TRUE if:

1. Dewatered Sludge Conveyors 1 OR 2 (14-ME-01-DWS OR 14-ME-03-DWS) Local/Remote Switches are in Remote AND the associated conveyor to a Switch in Remote is NOT FAILED.
2. Dewatered Sludge Conveyors 3 AND 4 (14-ME-03-DWS and 14-ME-04-DWS) Local/Remote Switches are both Remote AND both conveyors are NOT FAILED.
3. Gates 14-G-03-DWS OR 14 G-04-DWS associated with either Conveyor 14-ME-01-DWS OR 14-ME-02-DWS that are in Remote and NOT FAILED are in REMOTE (HS-P54-1 OR HS-P59-1) and the associated gate is OPEN.
4. Sludge Hopper 52-ME-10-DWS is NOT HIGH-HIGH as monitored by LSHH-O10.

Under the control revisions required under this Contract (per Section 14552), Dewatered Sludge Conveyors 14-ME-01-DWS, 14-ME-02-DWS, 14-ME-03 DWS, and 14-ME-04-DWS shall deliver dewatered sludge to the sludge hopper depending on the position of slide gates 14-G-02-DWS and 14-G-04-DWS. With either of these conveyors operating, level in the sludge hopper increases and enables operation of the Dryer system (see Loop O10) for a manual start. Sludge Hopper Full from LSHH-O10 shall immediately shutdown any operating conveyors operating in DRYER SETUP OK mode. Existing PLC logic in Panel 14-LP-03 shall be provided to the Contractor after Notice To Proceed.

The new Dryer conveyor system shall include a new package control panel (14-LP-10) furnished by the conveyor system supplier under Section 14552 and dedicated to control of new Dewatered Sludge Conveyors 14-ME-03-DWS and 14-ME-04-DWS and new Dryer conveyor slide gates 14-G-02-DWS and 14-G-04-DWS. Conveyors 1 and 2 shall remain controlled from Panel 14-LP-03.

New Panel 14-LP-10 shall include local functions and remote status, alarm, and controls for both new conveyors as follows and as shown on the Contract Documents:

- Conveyor START FWD, START REV, and STOP pushbuttons
- LOCAL/REMOTE Selector Switches
- Conveyors 14-ME-03-DWS and 14-ME-04-DWS low-speed shut down and Local Emergency Stop functions
- Open/Close conveyor 14-ME-01-DWS and 14-ME-02-DWS Dryer slide gate controls
- Additional Panel resident indications/alarming and related functions per Section 14557 and including

    - Conveyor motor running forward
    - Conveyor motor running reverse
    - Zero speed (Fail)
    - Emergency stop switch activated
    - Remote control selected

- Interlock – Sludge Hopper Full from LSHH-O10 shall immediately shutdown any operating conveyors operating in DRYER SETUP OK mode

The new package conveyor panel (14-LP-10) shall receive and act on the following commands from the existing conveyor panel (14-LP-03) PLC, when the applicable conveyor is in REMOTE:

At panel 14-LP-10:

- Receive Conveyor 1 and 2 RUN statuses as a permissive for enabling operation of Conveyors 3 and 4 for filling of the Dryer Sludge Hopper
- Provide Open/Close control and Open/Closed indication for the new pneumatically controlled gate used for sludge routing to Dryer (14-G-02-DWS and 14-G-04-DWS)
- Receive Emergency Stop, Low Speed, and other alarm conditions as shown on the Drawings or as specified and relay them to the Panel 14-LP-03 PLC for shutdown of all sludge conveyors and alarming at SCADA Central
- Refer to “O Loop” series (P&ID Area 52 Series) and Section 11600 for additional Dryer operation control descriptions and requirements.

At panel 14-LP-03:

- Receive equipment operational status and Shutdown signal from the new conveyor package panel (14-LP-10). On receipt of the Shutdown signal, alarm and cancel conveyor RUN outputs to ALL conveyors and shutdown the Belt Press.

- Modify the existing PLC in Panel 14-LP-03 accordingly for shutdown of all conveyor equipment and Belt Press system as presently implemented.

SCADA Central

- Monitor operational and failure status of new and existing conveyors and gates from the HMI in the Operations Building.
- Refer to “O Loop” series (P&ID Area 52 Series) and Section 11600 for additional Dryer operation control descriptions and requirements.

LOOP 14-P50

Dewatered Sludge Conveyor 1 (14-ME-01-DWS) Shutdown

P&ID: 14-I01

Description:

Operation of the renovated dewatered sludge conveyor (previously tagged 14-ME-01-SL) shall match existing controls from 14-LP-03 as modified for Dryer operation as described above. Provide new Emergency Shutdown of the Dewatered Sludge Conveyor 1 (14-ME-01-DWS)

Control:

Field:

Unit shutdown on:

Speed Switch Low (SSL-P50)

Local emergency stop (LES-P50) (existing)

Local (14-LP-03)

Speed Switch Low Conveyor Shutdown (STOP)

Remote (HMI at SCADA Central: 14-CP-01):

Reuse existing HMI control

Power Failure State

Emergency Stop remain true after power restoration until manually reset at the equipment

Alarms and Monitoring:

Field:

None

Local (14-LP-03):

Alarms

Update existing OIT alarms to include SSL

Status

Reuse existing OIT status

Remote (HMI at SCADA Central: 14-CP-01)

Alarms

Update existing HMI alarms to include SSL

Status

Reuse existing HMI status

Incorporate into PRESS 1 SETUP OK

Incorporate into PRESS 2 SETUP OK

Incorporate into DRYER SETUP OK

LOOP 14-P55

Dewatered Sludge Conveyor 2 (14-ME-02-DWS) Shutdown

P&ID: 14-I01

Functionally identical to Loop 14-P-50

LOOP 14-P52

Dewatered Sludge Conveyor 1 (14-ME-01-DWS) Pneumatic Knife Gate (14-G-01-DWS) and Solenoid Valves (14-SV-01-DWS and 14-SV-02-DWS)

P&ID: 14-I01

Description:

Activation of solenoid valve 14-SV-01-DWS opens pneumatic knife gate 14-G-01-DWS routing dewatered sludge from Belt Filter Press 1 to the existing North Bay Sludge Screw Conveyor. Activation of solenoid valve 14-SV-02-DWS closes pneumatic knife gate 14-G-01-DWS stopping the flow of dewatered sludge from Belt Filter Press 1 to the existing North Bay Sludge Screw Conveyor.

Control:

Field:

None

Local (14-LP-10)

Open Solenoid

Close Solenoid

Remote (HMI at SCADA Central):

Energize Open Solenoid (VlvOpen)

Energize Close Solenoid (VlvClose)

Power Failure State

Valve retains last state on power failure

Alarms and Monitoring:

Field:

None

Local (14-LP-03):

None

Remote (HMI at SCADA Central)

None

Status

Valve Open Command issued (VlvOpen)

LOOP 14-P54

Dewatered Sludge Conveyor 1 (14-ME-01-DWS) Pneumatic Knife Gate (14-G-02-DWS) and Solenoid Valves (14-SV-03-DWS and 14-SV-04-DWS)

P&ID: 14-I01

Description:

Activation of solenoid valve 14-SV-03-DWS opens pneumatic knife gate 14-G-02-DWS routing dewatered sludge to the new dewatering Sludge Conveyor 14-ME-03-DWS routing dewatered sludge Belt Filter Press 1 to the new Sludge Dryer Hopper. Activation of solenoid valve 14-SV-04-DWS closes pneumatic knife gate 14-G-02-DWS stopping the flow of dewatered sludge to the Sludge Dryer Hopper from Belt Filter Press 1.

Control:

Field:

None

Local (14-LP-10)

Open Solenoid

Close Solenoid

Remote (HMI at SCADA Central):

Energize Open Solenoid (VlvOpen)

Energize Close Solenoid (VlvClose)

Power Failure State

Valve retains last state on power failure

Alarms and Monitoring:

Field:

None

Local (14-LP-03):

None

Remote (HMI at SCADA Central)

None

Status

Valve Open Command issued (VlvOpen)

Incorporate into DRYER SETUP OK logic conditions

LOOP 14-P55

Dewatered Sludge Conveyor 2 (14-ME-02-DWS) Shutdown

P&ID: 14-I01

Description:

Functionally identical to Loop 14-P-50

LOOP 14-P57

Dewatered Sludge Conveyor 2 (14-ME-02-DWS) Pneumatic Knife Gate (14-G-03-DWS) and Solenoid Valves (14-SV-05-DWS and 14-SV-06-DWS)

P&ID: 14-I01

Functionally identical to Loop 14-P-52

LOOP 14-P59

Dewatered Sludge Conveyor 2 (14-ME-02-DWS) Pneumatic Knife Gate (14-G-04-DWS) and Solenoid Valves (14-SV-07-DWS and 14-SV-08-DWS)

P&ID: 14-I01

Functionally identical to Loop 14-P-54

LOOP 14-P60

Dewatered Sludge Conveyor 3 (14-ME-03-DWS)

P&ID: 14-I02

Description:

Operation of the new dewatered sludge conveyor 14-ME-03-DWS shall route dewatered sludge from either Belt Filter Press 1/Conveyor 1 (14-ME-01-DWS) or Belt Filter Press 2/Conveyor 2 (14-ME-02-DWS) to the Sludge Hopper (Loop 52-O10). Controls shall be as provided in a new Control panel 14-LP-10 from the Conveyor System Supplier per Section 14552.

Control:

Field:

None

Local (14-LP-10):

HS-P60-1 (Local/Remote) in Local

Manual control per Section 14552

Remote (HMI at SCADA Central):

HS-P60-1 (Local/Remote) in REMOTE and Conveyor NOT FAILED (ULA-60) incorporated into DRYER SETUP OK condition

See Conveyor General Description

Power Failure State

Manual Restart (Local or Remote) following restoration of power

Alarms and Monitoring:

Field:

Per Section 14552

Local (14-LP-10):

Per Section 14552

Remote (HMI at SCADA Central)

See Conveyor General Description

LOOP 14-P65

Dewatered Sludge Conveyor 4 (14-ME-04-DWS)

P&ID: 14-I02

Description:

Functionally identical to Loop 14-P60

Loop Series 21 (Oxidation Ditch 1), 22 (Oxidation Ditch 2), 23 (Aeration Basin 3), 24 (Aeration Basin 4), and 27 (Aeration Blower System):

Aeration System Operation Overview

General: Controls air flow to the Oxidation Ditches (Series 21 and 22) and Aeration Basins (Series 23 and 24) oxic zones based on either a pressure, air flow, dissolved oxygen (DO), or most open valve (MOV) strategy. Control modes for the Aeration Control System Series 27) are described in detail in Specification 13550 for implementation by the Aeration System Supplier.

Description: The Oxidation Ditches and Aeration Basins receive effluent from the Denitrification Basins. The Oxidation Ditches and Aeration Basins discharge the aerated Mixed Liquor stream to the Secondary Splitter Box.

There are two Oxidation Ditches (1 and 2) and each contains nine zones (A, B, C, D, E, F, G, H, I). The first four zones in the Oxidation Ditches (A, B, C and D) are anoxic containing mixing only, four zones are oxic (E, F, G, and H) and are aerated by control of butterfly valves to regulate air flow through fine bubble diffusers. Each oxic zone in the Oxidation Ditches shall be equipped with dissolved oxygen analyzers with air flow to each zone controlled independently based on the zone specific DO level. The final de-ox zone (Zone I) contains mixing only.

There are two Aeration Basins (3 and 4) and each contains nine zones (A, B, C, D, E, F, G, H, I). The first four zones in the Aeration Basins (A, B, C and D) are anoxic containing mixing only, four zones are oxic (E, F, G, and H) and are aerated by control of butterfly valves to regulate air flow through fine bubble diffusers. Each oxic zone in the Aeration Basins shall be equipped with dissolved oxygen analyzers with air flow to each zone controlled independently based on the zone specific DO level. The final de-ox zone (Zone I) contains mixing only.

Aeration of mixed liquor takes place in the oxic zones of the Oxidation Ditches and Aeration Basins. The high biochemical oxygen demand (BOD) of the mixed liquor requires an adequate supply of oxygen to allow the nitrification process to occur. This oxygen is delivered by forcing air from aeration blowers (Loop Series 27) through fine-bubble diffusers in the bottom of each oxic zone in each Aeration Ditch or Aeration Basin. Air flow from the aeration blowers is monitored by a flowmeter and regulated by a motorized butterfly valve in each oxic zone in each ditch or basin. There is also a manual valve that permits manual control of the air supply to each basin. The motorized butterfly valves are normally controlled automatically by the Blower System Master Control Panel (27-MCP-01) based on an air flow setpoint as determined by the 27-MCP-01 PLC. Blower system aeration control shall be developed and implemented by the Aeration System Supplier as specified under Section 13550.

The Blower System MCP shall be resident on the control system network as shown in the Contract Documents. All MCP variables for monitoring and control shall be passed to/from the plant SCADA Central system as specified under Section 13482 Part 1 and Part 3.

Dissolved oxygen (DO) analyzers shall measure DO in each oxic zone. DO levels shall provide input for determining the air flow setpoint for each zone. DO values measured above or below operator entered minimum and maximum setpoints beyond an operator adjustable timer, shall alarm at SCADA Central HMI and be removed from the aeration calculations until verification, troubleshooting, or recalibration can be performed. During the period of outage, the system shall retain last state for aeration values within that oxic zone affected by the failed analyzer.

An ammonia analyzers shall measure ammonium levels in Oxic Zone “F” and also provide input to the air flow setpoint for the oxic basins. The ammonia analyzer shall be relocatable to provide ammonium level at oxic zone “H” following aeration control system loop tuning and configuration.

Refer to Section 13550. Ammonium values measured above or below operator entered minimum and maximum setpoints beyond an operator adjustable timer, shall alarm at SCADA Central HMI and be removed from the aeration calculations until verification, troubleshooting, or recalibration can be performed. During the period of outage, the system shall retain last state for aeration values within the oxic areas of each ditch or basin affected by the failed analyzer.

A pressure transmitter shall measure air pressure in the common blower discharge header. Air pressure in the header shall be used to determine the air flow setpoint for each oxic zone as specified under Section 13550. Pressure values measured above or below operator entered minimum and maximum setpoints beyond an operator adjustable timer, shall alarm at SCADA Central HMI and be removed from the aeration calculations until verification, troubleshooting, or recalibration can be performed. During the period of outage, the system shall retain last state for air flow values within the oxic area of each ditch of basin affected by the failed analyzer.

LOOP 21-E10-1

Oxidation Ditch 1, Oxic Zone 1E Dissolved Oxygen Analyzer (21-AE/AIT-E10-1)

P&ID: 21-I-01

Description:

Dissolved oxygen (DO) analyzers shall measure DO in each oxic zone. DO levels shall provide input for determining the air flow setpoint for each zone. DO values measured above or below operator entered minimum and maximum setpoints beyond an operator adjustable timer, shall alarm at SCADA Central HMI and be removed from the aeration calculations until verification, troubleshooting, or recalibration can be performed. During the period of outage, the system shall retain last state for aeration values within that oxic zone affected by the failed analyzer.

Control:

Field:

None

Local (Aeration 27-MCP-01):

Used to determine aeration levels in Zone 1E. Refer to Section 13550.

Remote (HMI at SCADA Central):

None

Power Failure State

None

Alarms and Monitoring:

Field:

Dissolved Oxygen (AIT)

Analyzer Failure with self-diagnostics at analyzer/controller per 13431

Local (Aeration 27-MCP-01 OIT):

Dissolved Oxygen (AIT)

Remote (HMI at SCADA Central)

Dissolved Oxygen (AIT)

LOOP 21-E10-2

Oxidation Ditch 1, Oxic Zone 1F Dissolved Oxygen Analyzer (21-AE/AIT-E10-2)

P&ID: 22-I-01

Description:

Functionally identical to Loop E10-1

LOOP 21-E10-3

Oxidation Ditch 1, Oxic Zone 1G Dissolved Oxygen Analyzer (21-AE/AIT-E10-3)

P&ID: 22-I-01

Description:

Functionally identical to Loop E10-1

LOOP 21-E10-4

Oxidation Ditch 1, Oxic Zone 1H Dissolved Oxygen Analyzer (21-AE/AIT-E10-4)

P&ID: 22-I-01

Description:

Functionally identical to Loop E10-1

LOOP 21-E10-5

Oxidation Ditch 1, Oxic Zone 1E Ammonia Analyzer (21-AE/AIT-E10-5)

P&ID: 21-I-01

Description:

An ammonia analyzers shall measure ammonium levels in Oxic Zone “F” and also provide input to the air flow setpoint for the oxic basins. The ammonia analyzer shall be relocatable to provide ammonium level at oxic zone “H” following aeration control system loop tuning and configuration. Refer to Section 13550. Ammonium values measured above or below operator entered minimum and maximum setpoints beyond an operator adjustable timer, shall alarm at SCADA Central HMI and be removed from the aeration calculations until verification, troubleshooting, or recalibration can be performed. During the period of outage, the system shall retain last state for aeration values within the oxic areas of each ditch or basin affected by the failed analyzer.

Control:

Field:

None

Local (21-MCP-01):

Used to determine aeration levels in Zone 1E. Refer to Section 13550.

Remote (HMI at SCADA Central):

None

Power Failure State

None

Alarms and Monitoring:

Field:

Ammonium (AIT)

Analyzer Failure with self-diagnostics at analyzer/controller per 13431

Local (14-LP-10):

Ammonium (AIT)

Remote (HMI at SCADA Central)

Ammonium (AIT)

LOOP 21-E11

Oxidation Ditch 1 Anoxic Zone Low Speed Variable Speed Mixer 1-1 (21-ME-01-ML)

P&ID: 21-I-01

General: The Oxidation Ditch and Aeration Basin low speed mixers provide circulation of the mixed liquor within the four anoxic zones. Mixers are variable speed and are intended to operate continuously.

Description: In each Oxidation Ditch and Aeration Basin there is one (1) mixer in each of the anoxic zones A and B; and two (2) in each of the anoxic zones C and D. Mixers shall operate continuously when the zone is on line and the water level reaches the required height. Mixer speed shall be manually adjustable locally and remotely.

Control:

Field:

Mixer control via local mixer panel OIT (submersible mixer ASD). Refer to 11206 and notes shown on the Drawings.

Local (MCC):

Mixer control front panel switches and ASD OIT (MCC resident mixer ASD). Refer to 11206 and notes shown on the Drawings

Remote (HMI at SCADA Central):

Stop Pushbutton (HS)
Start Pushbutton (HS - Call)
Speed Setpoint (SIC)

Power Failure State

Automatic Restart after the adjustable power failure time delay following restoration of power

Alarms and Monitoring:

Field:

Mixer status via local mixer panel OIT (submersible mixer ASD). Refer to 11206 and notes shown on the Drawings.

Local (MCC):

Mixer status via local mixer panel OIT (submersible mixer ASD). Refer to 11206 and notes shown on the Drawings.

In Remote (HS)
Running (YL)
Failure (ULA)

Remote (HMI at SCADA Central)

In Remote (YL)
Running (YL)
Failure (ULA)

Additional status provided via equipment monitoring Modbus network per Section 11206

LOOP 21-E12

Oxidation Ditch 1 Anoxic Zone Low Speed Variable Speed Mixer 1-2 (21-ME-02-ML)

P&ID: 21-I-01

Description:

Functionally identical to Loop 21-ME-01-ML

LOOP 21-E13

Oxidation Ditch 1 Anoxic Zone Low Speed Variable Speed Mixer 1-3 (21-ME-03-ML)

P&ID: 21-I-01

Description:

Functionally identical to Loop 21-ME-01-ML

LOOP 21-E14

Oxidation Ditch 1 Anoxic Zone Low Speed Variable Speed Mixer 1-4 (21-ME-04-ML)

P&ID: 21-I-01

Description:

Functionally identical to Loop 21-ME-01-ML

LOOP 21-E15

Oxidation Ditch 1 Oxic Zone Low Speed Variable Speed Mixer 1-5 (21-ME-05-ML)

P&ID: 21-I-01

Description:

General: The Oxidation Ditch and Aeration Basin low speed mixers provide circulation of the mixed liquor within the four anoxic zones. Mixers are variable speed and are intended to operate continuously.

Description: In each Oxidation Ditch and Aeration Basin there is one (1) mixer in each of the anoxic zones A and B; and two (2) in each of the anoxic zones C and D. Mixers shall operate continuously when the zone is on line and the water level reaches the required height. Mixer speed shall be manually adjustable locally and remotely.

Otherwise functionally identical to Loop 21-ME-01-ML

LOOP 21-E16

Oxidation Ditch 1 Oxic Zone Low Speed Variable Speed Mixer 1-6 (21-ME-06-ML)

P&ID: 21-I-01

Description:

Functionally identical to Loop 21-ME-05-ML

LOOP 21-E17

Oxidation Ditch Mixed Liquor Recycle Wall Pump 1-1 (21-P-04-ML)

P&ID: 21-I-01

General: The Oxidation Ditch and Aeration Basin mixed liquor recycle (MLR) pumps shall pump mixed liquor from each oxic zone H to de-ox zone I. This pumping effectively recycles a portion of the mixed liquor proportional to effluent flow. Mixers are constant speed and are intended to operate continuously.

Description: In each Oxidation Ditch there are two (2) MLR pumps mounted to the wall between oxic zone H and de-ox zone I. In each Aeration Basin there are one (1) MLR pump mounted to the wall between oxic zone H and de-ox zone I. Mixers shall operate continuously when the zone is on line and the water level reaches the required set point.

Control:

Field (21-CS-07):

In Remote (HS-1)
Start Pushbutton (HS-2)
Stop Pushbutton (HS-3)

Local (MCC):

Reset (HS-4)

Remote (HMI at SCADA Central):

Call (HS - Call)

Power Failure State

Automatic Restart after the adjustable power failure time delay following restoration of power

Alarms and Monitoring:

Field (21-CS-07):

On (YL-1)
Off (YL-2)

Local (MCC):

Overtemp (TLH)
Fail (ULA)
On (YL-3)
Off (YL-4)

Remote (HMI at SCADA Central)

High Temp (TLH)
Fail (ULA)
In Remote (YL)
Running (YL-3)

LOOP 21-E18

Oxidation Ditch Wall Pump 1-2 (21-P-05-ML)

P&ID: 21-I-01

Description:

Functionally identical to Loop 21-P-04-ML

LOOP 21-E19

Oxidation Ditch Deox Zone High Speed Compact Mixer 1-7 (21-ME-07-ML)

P&ID: 21-I-01

General: The Oxidation Ditch and Aeration Basin high speed compact mixers provide circulation of the mixed liquor within the de-ox zones. Mixers are constant speed and are intended to operate continuously.

Description: In each Oxidation Ditch and Aeration Basin there is one (1) mixer in the de-ox zone I. Mixers shall operate continuously when the zone is on line and the water level reaches sufficient height for manual operation.

Control:

Field (21-CS-09):

In Remote (HS-1)
Start Pushbutton (HS-2)
Stop Pushbutton (HS-3)

Local (MCC):

Reset (HS-4)

Remote (HMI at SCADA Central):

Call (HS - Call)

Power Failure State

Automatic Restart after the adjustable power failure time delay following restoration of power

Alarms and Monitoring:

Field (21-CS-09):

On (YL-1)
Off (YL-2)

Local (MCC):

Overtemp (TLH)
Fail (ULA)
On (YL-3)
Off (YL-4)

Remote (HMI at SCADA Central)

High Temp (TLH)
Fail (ULA)
In Remote (YL)
Running (YL-3)

LOOP 21-E20

Oxidation Ditch 1 Oxic Zone 1E Air Flowmeter (FE/FIT-21-E20) and Control Valve (21-V-02-AA)

P&ID: 21-I-02

Description:

Air flow from the aeration blowers is monitored by a flowmeter and regulated by a motorized butterfly valve in each oxic zone in each ditch or basin. There is also a manual valve that permits manual control of the air supply to each basin. The motorized butterfly valves are normally controlled automatically by the Blower System Master Control Panel (27-MCP-01) based on an air flow setpoint as determined by the 27-MCP-01 PLC. Blower system aeration control shall be developed and implemented by the Aeration System Supplier as specified under Section 13550.

Control:

In Local mode the valve position is controlled from the actuator based Open-Stop-Close selector switch.

In Remote mode the valve position is controlled by the vendor supplied Aeration Control Panel 27-MCP-01. In the panel Manual mode the valve position may be controlled from the panel OIT. In the panel Auto mode, the vendor panel modulates the valve position (control variable) under a proportional-integral-derivative algorithm to achieve the desired aeration levels for the particular oxic zone be achieving the desired flowrate (calculated setpoint) as measured by the flowmeter (process variable)

Field:

Local-Off-Remote Selector (HS-1)
Open Pushbutton (HS-2)
Stop Pushbutton (HS-3)
Close Pushbutton (HS-4)

Local (27-MCP-01):

Auto-Manual OIT Selector (HS-M)
Valve Open OIT Pushbutton (HS-D)
Valve Close OIT Pushbutton (HS-E)

See also Aeration System Description, Section 13550

Remote (HMI at SCADA Central):

None

Power Failure State

Valve shall fail closed during power failure

Alarms and Monitoring:

Field:

Flowmeter readout (FIT)
Valve Fully Open (ZLL)
Valve Fully Closed (ZLH)\

Local (27-MCP-01):

Flowmeter readout (FIT)
Refer also to Section 13550

Remote (HMI at SCADA Central)

All monitored variables shall be shown on the SCADA Central HMI. Refer to Section 13550 and 13482, Part 1 and Part 3

LOOP 21-E21

Oxidation Ditch 1 Oxic Zone 1F Air Flowmeter (FE/FIT-21-E21) and Control Valve (21-V-04-AA)

P&ID: 21-I-02

Description:

Functionally identical to Loop 21-E20

LOOP 21-E22

Oxidation Ditch 1 Oxic Zone 1G Air Flowmeter (FE/FIT-21-E22) and Control Valve (21-V-06-AA)

P&ID: 21-I-02

Description:

Functionally identical to Loop 21-E20

LOOP 21-E23

Oxidation Ditch 1 Oxic Zone 1H Air Flowmeter (FE/FIT-21-E23) and Control Valve (21-V-08-AA)

P&ID: 21-I-02

Description:

Functionally identical to Loop 21-E20

Loop Series 22- Oxidation Ditch 2

P&ID: 22-I-01 and 22-I-02

Description:

Oxidation Ditch 2 Loops are functionally equivalent to the associated Oxidation Ditch 1 Loops

Loop Series 23- Aeration Basin 3

P&ID: 23-I-01 and 23-I-02

Description:

Aeration Basin 3 Loops are functionally equivalent to the associated Oxidation Ditch 1 Loops

Loop Series 24 – Aeration Basin 4

P&ID: 24-I-01 and 24-I-02

Description:

Aeration Basin 4 Loops are functionally equivalent to the associated Aeration Basin 3 Loops

AERATION SYSTEM CONTROL OVERVIEW

P&ID 27 Series

General: Controls air flow to the Oxidation Ditch and Aeration Basin oxic zones based on either a pressure, air flow, dissolved oxygen (DO), or most open valve (MOV) strategy. Control modes are described in detail in Specification 13550 Aeration Control System.

Description: Refer to the General Aeration System description located before loop descriptions for Oxidation Ditch 1 (Loop Series 21)

AERATION BLOWER SYSTEM CONTROL OVERVIEW

P&ID 27 Series

General: The blower system provides air to the fine bubble diffuser system in each oxic zone. See Aeration System Control strategy for utilization.

Blower manufacturers shall also supply the flowmeters, control valving, and DO instrumentation that control air flow into each oxic zone. By requiring blower manufacturers to supply a complete blower and aeration control system, blower manufacturers shall have the responsibility for delivering a complete, programmed, and functioning aeration system.

SCADA Central shall receive acquire all operational data from the Aeration Blower system for monitoring, display, and historical archiving of the Aeration system delivered by the Aeration System supplier. Refer to Sections 11502, 13550, and 13482 Part 1 and Part 3.

Description: There are three duty geared single stage centrifugal blower packages and one standby located in the Blower Building. Each duty blower is sized to deliver a maximum of 4,650 scfm. Each duty blower must also deliver a minimum of 1,860 scfm while maintaining an acceptable efficiency and not surging.

The blower package system consists of the four blowers, each with its own local control panel (LCP) and a master blower control panel (MCP) supplied as part of the Aeration Control System. The MCP shall sequence and operate blowers as needed to achieve the setpoint given the prevailing flow conditions per the operating modes described in the specifications. The MCP shall communicate via a digital link with the plant PLC control system.

Refer to Aeration System Control strategy (Section 13550) and Specification Section 11502, which describes operations, controls, and sequencing logic which is part of the packaged system.

LOOP 27-E10

Blower 1 (27-B-01-AA)

P&ID: 27-I-01

Description:

Aeration Blower 1 is part of the Blower System package suppling air to the oxidation ditches and aeration basins as described above.

Control:

Field:

None

Local (27-RVSS-01-AA):

Local-Off-Remote Selector (HS-1)
Start Pushbutton (HS-2)
Stop Pushbutton (HS-3)
Reset Pushbutton (HS-4)
Automated Blower Call (from 27-MCP-01)

Remote (HMI at SCADA Central):

None

Power Failure State

Automatic Restart after the adjustable power failure time delay following restoration of power

Alarms and Monitoring:

Field:

None

Local (27-RVSS-01-AA):

Running (YL)
Fail (ULA)

Remote (HMI at SCADA Central)

All status and alarms for Aeration system shall be monitored and displayed at SCADA Central

LOOP 27-E20

Blower 2 (27-B-02-AA)

P&ID: 27-I-01

Functionally equivalent to Loop 27-E10

LOOP 27-E30

Blower 3 (27-B-03-AA)

P&ID: 27-I-02

Functionally equivalent to Loop 27-E10

LOOP 27-E40

Blower 4 (27-B-02-AA)

P&ID: 27-I-02

Functionally equivalent to Loop 27-E10

LOOP 34-G1

Secondary Clarifier 3 (34-ME-01-ML)

P&ID: 34-I-01

Description:

Secondary Clarifier No. 3 (clarifier) receives flow from the oxidation ditches and new aeration basins via the secondary splitter box. There are two existing Secondary Clarifiers (No. 1 and No. 2) that also receive flow from the Secondary Splitter Box. Secondary Clarifier No. 3 has the same capacity as Secondary Clarifier No. 1 and No. 2. The circular secondary clarifier shall include a constant-speed drive clarifier mechanism.

Mixed liquor (ML) flows by gravity from the secondary splitter box into the clarifier through a 30-inch pipe. ML is discharged into the clarifier at the center of the clarifier through the influent feedwell. The feedwell distributes the flow of ML across the circumference of the clarifier.

As the ML flows outwards towards the circumference of the clarifier, it stratifies into the scum, supernatant (secondary effluent, and subnatant (sludge). Clarifier skimmers and sludge removal arms are used to collect the scum and sludge, respectively, into a centralize collection box (for scum) and hopper (for sludge). The clarifier skimmers and sludge removal arms are driven by a single drive mechanism (Secondary Clarifier Drive Mechanism #3 (34-ME-01-ML) with control station (34-CS-01).

Scum is collected through the scum beach, where it flows by gravity to the scum pumps.

Sludge is collected in the sludge hopper at the bottom of the clarifier, where it flows by gravity to the RAS pumps (Loop Series 36).

Control:

Field:

None

Local (34-CS-01):

Operator controls clarifier mechanism when in Local mode. Alarm RESET only occurs locally at 34-CS-01.

- LOCAL/REMOTE (HS-1) in LOCAL
- START/STOP (HS-2/HS-3)
- Alarm RESET (HS-4)

Remote (MCC):

- Mechanism shutdown on High-High Torque (NSHH)

Remote (HMI at SCADA Central):

Operator can implement remote clarifier operation (ON/OFF) when panel 34-CS-01, HS-1 is in REMOTE.

- Clarifier Call (CALL)
- Scum Box Spray Water Solenoid Valve (SV-01-UW) Open (VlvOpen)

Power Failure State:

- All controls and instruments through the 34-CS-01 fail into a safe condition.
- Clarifier shall restart automatically when HS-1 in REMOTE from Plant SCADA after the adjustable power failure time delay following restoration of power. HS-1 in LOCAL mode restart requires the Operator to initiate restart from 34-CCS-01 START/STOP (HS-2/HS-3) Pushbuttons.
- Incorporate existing shutdown alarms from existing clarifier pump as a permissive for clarifier 3 restart via SCADA.

Alarms and Monitoring:

Field:

- Rotating Beacon (NLH-3) Alarm on High Torque

Local (CS):

- ON/OFF Status (YL-1/YL-2)
- Alarm on High Torque (NLH)
- Alarm on High-High (Shutdown) Torque (NLHH)

Remote (MCC):

- ON/OFF Status (YL-3/YL-4)
- Fail (ULA-G1)
- Alarm on High Torque (NLH-G1-2)
- Alarm on High-High (Shutdown) Torque (NLHH-G1-2)

Remote (HMI at SCADA Central):

- LOR Switch in Remote (Remote)
- ON/OFF Status (Running)
- Fail (Fail)
- Alarm on High Torque (High)
- Alarm on High-High (Shutdown) Torque (High-High)

LOOP Series 36 – RAS Pumping

General: Two adjustable-speed RAS pumps, Pump 5 (36-P-02-RAS) and Pump 6 (36-P-03-RAS) return sludge from Secondary Clarifier No. 3 (Loop 34-G1) to the denitrification basins, downstream of the headworks. Normally, a single duty pump is manually valved to Clarifier No. 3, with the second pump acting as a standby unit. Under normal conditions, the duty pump is automatically controlled by the PLC in one of two modes: constant RAS flow independent of or RAS flow dependent on defined flow streams.

Operator can implement remote RAS operation When panel 36-CS-01, HS-1 is in REMOTE. Based on manual valve positioning, Operator selects Duty Pump and Constant Flow or Plant Flow Paced Mode selected from the HMI. When selected Duty ASD is in REMOTE, provide HMI-based MANUAL/AUTO selection. When selected MANUAL, provide manual START/STOP and SPEED controls. When selected AUTO, provide mode selection for CONSTANT FLOW or PLANT FLOW PACED control and provide manual START/STOP with pump speed automatically adjusted to achieve the control desired.

The existing RAS pumps receive existing RAS flow signals and existing WAS flow signals from loop H15 and Unit Process P (existing solids handling). WAS flow is diverted from the pipeline downstream of the RAS flowmeters; therefore, for the purpose of determining actual RAS returned to the denitrification area, the WAS flows must be netted out. For either automatic mode, the PLC shall calculate net RAS flow by subtracting the sum of WAS flows from the sum of existing and new RAS flows.

Modify the existing RAS pump station control algorithm to incorporate the new RAS pump flows (measured vis FE/FIT-H4) and the WAS flowrate to the WAS Storage Tanks for the modified control algorithms.

- Constant Flow Mode: This mode shall automatically adjust pump speed to control net RAS flow to a configurable set point. All RAS pumps shall be driven at the same speed.

- Plant Flow Paced Mode: This mode shall result in net RAS being a function of total plant influent flow, as monitored by loop C5. Using PI control of pump speed, with all pumps driven at the same speed, control net RAS flow to the calculated set point as described below:

$$(R1 + R2 + R3) - (W) = (Q_B * X) + (Q - Q_B) * Y$$

Where:

- (R1 + R2 + R3) is the RAS flowrate where
  - R1 (existing FE/FIT H4-2), and R2 (existing FE/FIT H4-1) are gross RAS flows monitored at the existing RAS pump station from Clarifier Nos. 1 and 2, respectively.
  - R3 (new FE/FIT H4) is the gross RAS flow monitored at the new RAS pump station from Clarifier No. 3.

- W is the WAS flow diverted downstream of RAS flowmeters. If WAS is pulled from the WAS Storage Tanks to the belt filter feed pumps, W is flow measured from new FE/FIT N1. If WAS is pulled from the RAS lines to the belt filter feed pumps, W is the sum of flows from existing belt press feed pumps (FE/FIT P3+FE/FIT P4+FE/FIT P5)
- X is the operator entered RAS ratio (valid range: 0.25 to 1.25)
- Q is influent flow (existing loop C5)
- Q_B is the operator entered “base” flow (valid range 0 to 10 MGD)

- Y is the operator RAS increase ratio (valid range 0.0 to 1.0)

When preparing to press sludge with the existing belt filter presses, in advance of a pressing cycle, reduce RAS pumping rate to either of the following:

- Operator entered preset low constant flow, or
- Operator entered preset low-flow paced rate for a configurable interval. (Modify existing Unit Process series P for sludge pressing logic.)

LOOP 36-H2

RAS Pump 5 (36-P-02-RAS)

P&ID: 36-I-01

Control:

Field:

None

Local (36-CS-01): Operator controls RAS pump ON/OFF when in Local mode.

- LOCAL/REMOTE (HS-1) in LOCAL
- START/STOP (HS-2/HS-3)

Remote (MCC): Operator controls RAS pump speed when 36-CS-01, HS-1 is in REMOTE

- ASD ON/OFF and Speed Control via ASD HMI
- ASD Alarm RESET
- Seal Water Flow SOV (36-SV-02-UW) interlocked with Pump CALL
- Shutdown on low seal water (FSL)

Remote (HMI at SCADA Central):

- Duty Pump Call (CALL)
- In the event of low flow in the utility water system, initiate an alarm and shut down (or do not start) the Duty pump. Lock out both RAS pumps until the alarm is manually reset at the HMI.
- Bypass contactors are included with the drives to allow across-the-line starting. When selected BYPASS and REMOTE, provide manual START/STOP control. Automatic control using the bypass contactors is not provided and control shall be in Manual mode only.

Power Failure State:

- Retain last flow rate
- REMOTE restart shall allow the RAS pumps to be restarted Manually via the MCC or SCADA HMI or via auto-restart. Local restart requires the Operator to initiate restart manually from 36-CS-01
- Alarms causing RAS pump shutdown at the MCC shall be cleared (RESET) before restart can be initiated locally from 36-CS-01 or the SCADA HMI

Alarms and Monitoring:

Field:

None

Local (36-CS-01)

- ON/OFF Status (YL-1/YL-2)
- Speed Indication (SI)
- Alarm on Low Seal Water Flow (FSL)

Remote (MCC):

- ASD ON Status (YL-3)
- ASD FAIL (ULA)
- ASD High Temp (TLH)

Remote (HMI at SCADA Central):

- ASD IN REMOTE (Remote)
- ASD ON (On)
- ASD Speed indication (%)
- ASD High Temp (TAH)
- ASD Fail (Fail)

LOOP 36-H3

RAS Pump 6 (26-P-03-RAS)

P&ID: 36-I-01

Functionally equivalent to Loop 36-H2

LOOP 36-H4

RAS Flow Monitoring

P&ID: 36-I-01

General: Flow meter (FE/FIT-H4), located upstream of the RAS pumps 5 and 6, monitors sludge flowrate from Secondary Clarifier No. 3. Sludge flowrate is needed to calculate the required wasting rate (i.e., WAS flowrate) needed to achieve a specific recycle rate (i.e., RAS flowrate). See Loop H2 and H3.

Control:

Field:

None

Local (CS):

None

Remote (MCC):

None

Remote (HMI at SCADA Central):

Used as part of RAS flow pacing. See General Description

Power Failure State

Not applicable

Alarms and Monitoring:

Field:

Flow (FIT)

Local (CS):

None

Remote (MCC)

None

Remote (HMI at SCADA Central)

Flow (FIT)

LOOP Series 36 – Secondary Scum Pumps No. 3 and No. 4 (36-P-01-S and 36-P-02-S)

P&ID: 36-I-02

General: The Scum Pit receives scum from the Secondary Clarifier No. 3. When the Scum Pit reaches HIGH level or when a SCUM REQUESTED signal is received from the belt press loop (existing Series "P"), a scum pumping sequence shall be initiated as follows:

a. Existing discharge valves (12-V-01-S and 12-V-02-S) are positioned (manually operated, field verified)
b. Run scum pit mixing blower (36-B-01-FA)
c. Run Duty scum pump(s) 36-P-01-S or 36-P-02-S
d. Stop scum pit mixing blower (36-B-01-FA)
e. Stop Duty scum pump(s) 36-P-01-S or 36-P-02-S

When a scum pumping sequence is not occurring, the scum pit mixing blower shall run 30 minutes ON and 30 minutes OFF in a continual cycle (times adjustable).

Description: Automatically operate the scum pumps, valves 12-V-01-S and 12-V-02-S, and the scum pumps based on level in the sump and SCUM REQUESTED signal from the belt press loop (existing Loops P Series). Equipment selected for automatic operation (see individual loops) shall be controlled in AUTO/REMOTE mode from the SCADA system as described.

For the scum pumps, provide automatic pump alternation and manual DUTY/STANDBY selection at the LCP. When a scum pump is required, run the duty pump.

If the duty pump fails to start, initiate FAIL alarm, lock out the duty pump pending an Operator Reset, and start the standby pump.

Provide a manually entered ASD speed setting for use in "pump-down" mode. When the scum sump reaches HIGH level (LSH-H6), a PUMP-DOWN mode scum pumping sequence shall be initiated as follows:

1 Command 12-V-01-S OPEN.

2 Verify 12-V-01-S is OPEN.

3 Command 12-V-02-S CLOSE.

4 Verify 12-V-02-S is CLOSED.

5 RUN scum pit mixing blower (36-B-01-FA) for an operator adjustable interval, initially set at 15 seconds.

6 RUN duty scum pump at preset ASD speed.

7 STOP scum pit mixing blower at low level (LSL-H6).

8 STOP duty scum pump at low level (LSL-H6).

When a SCUM REQUESTED signal is received from the belt press loop (existing "P" Series Loops), commence a "PRESS" mode scum pumping sequence. Receive a SPEED command from the press loop.

1. Command 12-V-02-S OPEN.

2. Verify 12-V-02-S is OPEN.

3. Command 12-V-01-S CLOSE.

4. Verify 12-V-01-S is CLOSED.

5. Run scum pit mixing blower (36-B-01-FA) for a configurable interval, set to 15 seconds.

6. Run duty scum pump at speed dictated by belt press loop (Existing “P” Series).

7. Stop scum pit mixing blower at low level (LSL-H6) or when pump is stopped below.

8. Stop duty scum pump when SCUM REQUESTED signal is removed or on low level (LSL-H6), whichever occurs first.

Should SCUM REQUESTED be received during a PUMP DOWN, Execute the following:

1. Command pump speed as requested by belt press loop. Command 12-V-02-S OPEN.

2. Verify 12-V-02-S is OPEN.

3. Command 12-V-01-S CLOSE.

4. Verify 12-V-01-S is CLOSED.\

5. Continue with PRESS mode pumping as described earlier.

In the event of low level in the scum sump, stop the pump.

Under any mode of operation, should a scum pump be called for or detected ON, if both 12-V-01-S and 12-V-02-S are closed, initiate an alarm and prevent the pump from starting (or shut down any pump which is running).

Under any mode of operation, should either existing Scum Pump No .1 or No. 2 (33-P-01-S or 33-P-02-S) be operating, Scum Pump No. 3 or No. 4 shall be OFF and inhibited from operating. Provide similar logic for existing Scum Pumps No. 1 and No. 2 if Scum Pump No. 3 and No. 4 are operating to avoid high headlosses in the scum pipeline.

LOOP 36-H5

Scum Pit Mixing Blower 2 (36-B-01-FA)

P&ID: 36-I-02

Description:

Scum pit mixing blower provides air through diffusers into the Scum Pit

Control:

Field:

None

Local (36-CS-03):

- LOCAL/REMOTE (HS-1) in LOCAL
- START/STOP (HS-2/HS-3)

Local (MCC):

- Alarm Reset (HS-4)

Remote (HMI at SCADA Central): With HS-1 In REMOTE

- Blower Call (CALL)

Power Failure State

Automatic return to previous operating state (Off or Running) on restoration of power

Alarms and Monitoring:

Field:

None

Local (36-CS-03):

- ON (YL-1)
- OFF (YL-2)

Local (MCC):

- ON (YL-3)
- OFF (YL-4)
- FAIL (ULA)
- Overtemp (TLH)

Remote (HMI at SCADA Central)

- In Remote (REMOTE)
- Running (RUNNING)
- High Temp (TAH)
- Fail (FAIL)

LOOP 36-H6

Scum Pit Level Switches (36-LSXX-H6)

P&ID: 36-I-02

Description:

Level switches installed in the Scum Pit are used as control and alarm levels for blower and scum pump control and remote alarming

Control:

Field:

None

Local (36-CS-03 and 36-CS-04):

None

Remote (MCC)

None

Remote (HMI at SCADA Central):

Control Scum Pumps (36-P-01-S and 36-P-02-S) and Scum Pit Blower (36-B-01-FA) as described

Power Failure State

Not Applicable

Alarms and Monitoring:

Field:

None

Local (36-CP-03 and 36-CP-04):

None

Remote (MCC):

None

Remote (HMI at SCADA Central)

Low-Low Level Switch (LSLL)

Low Level Switch (LSL)

High Level Switch (LSH)

High-High Level (LSHH)

LOOP 36-H7

Secondary Scum Pump No. 1 (36-P-01-S)

P&ID: 36-I-02

Description:

The Secondary Scum Pumps pump scum from the Scum Pit which receives scum Secondary

Clarifier No. 3. When the Scum Pit reaches HIGH level or when a SCUM REQUESTED signal is received from the belt press loop (existing Series "P") the Secondary Scum Pumps pump to either the Solids Handling (Belt Press) or the Screening Influent Channel. Based on the state of existing Valves 12-V-01-S or 12-V-02-S respectively.

Control:

Field:

None

Local (36-CS-04): Operator controls Secondary Scum Pump in LOCAL.

- LOCAL/REMOTE (HS-1) in LOCAL
- START/STOP (HS-2/HS-3)

Remote (MCC): Operator controls Secondary Scum Pump speed when 36-CS-04, HS-1 is in REMOTE.

- ASD ON/OFF and Speed Control (via ASD HMI)
- ASD Alarm RESET
- Seal Water Flow SOV (36-SV-04-UW) interlocked with Pump CALL
- Shutdown on low seal water (FSL)

Remote (HMI at SCADA Central):

- Duty Pump Call (CALL)
- In the event of low flow in the utility water system, initiate an alarm and shut down (or do not start) the Duty pump. Lock out both Secondary Scum Pumps until the alarm is manually reset at the HMI.
- Bypass contactors are included with the drives to allow across-the-line starting. When selected BYPASS and REMOTE, provide manual START/STOP control. Automatic control using the bypass contactors is not provided and control shall be in Manual mode only.

Power Failure State:

- Retain last flow rate
- REMOTE restart shall allow the Secondary Scum Pumps to be restarted Manually via the MCC or SCADA HMI or via auto-restart. Local restart requires the Operator to initiate restart manually from 36-CS-04
- Alarms causing Secondary Scum Pump shutdown at the MCC shall be cleared (RESET) before restart can be initiated locally from 36-CS-04 or the SCADA HMI

Alarms and Monitoring:

Field:

None

Local (36-CS-04)

- ON/OFF Status (YL-1/YL-2)
- Speed Indication (SI)
- Alarm on Low Seal Water Flow (FSL)

Remote (MCC):

- ASD ON Status (YL-3)
- ASD FAIL (ULA)
- ASD High Temp (TLH)

Remote (HMI at SCADA Central):

- ASD IN REMOTE (Remote)
- ASD ON (On)
- ASD Speed indication (%)
- ASD High Temp (TAH)
- ASD Fail (Fail)

LOOP 36-H8

Secondary Scum Pump No. 2 (36-P-02-S)

P&ID: 36-I-02

Functionally equivalent to Loop 36-H7

LOOP 36-H11

RAS Pump Station Sump Level Monitoring

P&ID 36-I-03

Level switches installed in the RAS Sump Pit are used as control and alarm levels for RAS Pump Station Sump Pump control and remote alarming

Control:

Field:

None

Locals (36-CS-06 and 36-CS-90):

None

Remote (MCC)

None

Remote (HMI at SCADA Central):

Low-Low Level Switch (LSLL) – All pumps Off

Low Level Switch (LSL) – Lead Pump Off

High Level Switch (LSH) – Lead Pump On

High-High Level (LSHH) – Both Pumps On

Power Failure State

Not Applicable

Alarms and Monitoring:

Field:

None

Local (36-CP-03):

None

Remote (MCC):

None

Remote (HMI at SCADA Central)

Low-Low Level Switch (LSLL) - Alarm

Low Level Switch (LSL) - Status

High Level Switch (LSH) - Status

High-High Level (LSHH) - Alarm

LOOP 36-H12:

RAS Sump Pump No. 1 (36-P-01-PD)

P&ID 36-I-03

General: Pumps plant drain flow from RAS building. Submersible pumps operate as Lead and Lag with automatic alternation on pump cycle.

Control:

Field:

None

Local (36-CS-06):

- LOCAL/REMOTE (HS-1) in LOCAL
- START/STOP (HS-2/HS-3)

Local (MCC):

- Alarm Reset (HS-4)

Remote (HMI at SCADA Central): With HS-1 In REMOTE

- Pump Call (CALL)

Power Failure State

Automatic return to previous operating state (Off or Running) on restoration of power

Alarms and Monitoring:

Field:

None

Local (36-CS-06):

- ON (YL-1)
- OFF (YL-2)

Local (MCC):

- ON (YL-3)
- OFF (YL-4)
- FAIL (ULA)
- Overtemp (TLH)
- Seal Leak (MLH)

Remote (HMI at SCADA Central)

- In Remote (REMOTE)
- Running (RUNNING)
- High Temp (TAH)

- Seal Leak (MAH)
- Fail (FAIL)

LOOP 36-H13

RAS Pump Station Sump Pump 4 (36-P-02-PD)

P&ID: 36-I-03

Functionally Equivalent to Loop 36-H12

LOOP 50-J10

Filter Loading Flowmeter

P&ID: 50-I-01

General: The Filter Loading Flowmeter (FE/FIT-J10), monitors the total flow to all the filters from the Filter Pumping Plant. The filter loading rate is the total flow to all the filters in service divided by the total area of all the filters in service. Each filter has a surface area of 513 ft^2. Provide an alarm if the filter loading rate exceeds 5 gpm/ft^2.

Control:

Field:

None

Remote (HMI at SCADA Central):

None

Power Failure State

None

Alarms and Monitoring:

Field:

None

Local (CS):

None

Remote (MCC)

None

Remote (HMI at SCADA Central)

High High Filter Loading Rate (FI)

LOOP 50-J12-1

Ammonia Monitoring

P&ID: 50-I-01

General: Ammonia Analyzer (AE/AIT-J12-1), monitors low levels of Ammonia from a sample line pulled from the existing Splitter Box. Ammonia analyzer monitors ammonia prior to the free chlorine addition and to assist with optimization of the secondary treatment to minimize the possibility of ammonia breakthrough. Provide alarm if ammonia levels exceed operator set point, initially set at 5 mg/L-N.

Control:

Field:

None

Remote (HMI at SCADA Central):

None

Power Failure State

Not applicable

Alarms and Monitoring:

Field:

Ammonia Level (AIT)

Local (CS):

None

Remote (MCC)

None

Remote (HMI at SCADA Central)

Ammonia Level (AI)

LOOP SERIES "N"

WAS STORAGE TANK CONTROL OVERVIEW

Description: The purpose of the WAS Storage Tanks is to decouple wasting and dewatering, that shall allow wasting from the secondary process to occur when the dewatering process is offline. Tanks also provide a means for consistent WAS feed to the existing Belt Filter Presses.

The WAS Storage Tanks receive waste activated sludge (WAS) from two return activated sludge (RAS) lines. There are three WAS storage tanks (1, 2, and 3). Each tank is aerated to keep solids mixed, in suspension, and to prevent the generation of odors by delivering oxygen to the stored biological population.

WAS WASTING RATE

General: Controls WAS daily flow to the WAS Storage Tanks to either: 1) maintain a solids retention time (SRT) in the secondary process or 2) waste an operator specified volume of WAS per day.

Description: WAS is wasted from two return activated sludge (RAS) lines and stored in the WAS storage tanks. There are two modes that control the wasting rate: SRT and VOLUME.

SRT Mode

A SCADA based control automatic mode based on maintaining a solids retention time in the secondary process. In SRT mode, flow to the WAS storage tanks is based on the following equation:

$$Q_W = \frac{VX}{X_R(SRT)}$$

Where Q_W = WAS flow (gallons per day)

V = Volume of oxidation ditches plus aeration basins (gallons) in operation (operator set point, initially set at 8.06 million gallons)

X = Oxidation ditches/aeration basins average mixed liquor suspended solids concentration (milligrams per liter) (operator set point and based on daily grab samples)

X_R = Return activated sludge concentration (milligrams per liter) (operator set point, initially based on 7-day averaged as measured by WAS storage tank influent suspended solids meter)

SRT = Desired solids retention time (days) (operator set point, initially set at 17 days)

VOLUME Mode

Shall be based on either an operator set point for gallons wasted per day or flow pace based on influent flow.

Alarms and Monitoring:

Remote (HMI at SCADA Central)

Provide status mode for each operational condition. In addition to the process variables and equipment status/alarming as noted below incorporate additional monitoring to include:

- WAS TSS
- Tank Levels
- WAS total flow rate
- 7-day average WAS concentration
- Influent valves Open/Close/Position

Control:

Provide system controls as described. In addition, if both RAS pump stations are in operation, the valve positions will be interlocked to provide approximately equal flow split between the two pump stations

WAS STORAGE TANK FILL/DRAW/HOLD

General: Controls filling and emptying of the three storage tanks.

Description: WAS is stored in each of three storage tanks where filling of each tank is based on wasting rate and emptying is based on the feed rate to the existing Belt Filter Presses. That is, the rate of draw (emptying) from the WAS storage tanks equals the feed rate to the Belt Filter Presses. WAS can also be held in the tanks to be able to waste while the existing Belt Filter Presses are not operating, such as during weekends or if failure of the Belt Filter Presses is encountered.

The storage tanks' influent (51-V-01-WAS, 51-V-02-WAS, and 51-V-03-WAS) and effluent control valves (51-V-04-WAS, 51-V-05-WAS, and 51-V-06-WAS) are motorized and are controlled by the plant SCADA system. The PLC will control the valve operation at EACH tank based on one of four operating modes selectable by the Operator at the SCADA system HMI: FILL, DRAW, HOLD, and DECANT.

FILL Mode:

- Initiate by opening of one of three influent valves (one per tank) by a call from the WASTING RATE control loop.
- Tanks will be filled in sequence (operator input, initially set at 1, 2, and 3).
- Operator shall have the ability to select a tank or tanks as "UNAVAILABLE". A tank identified as UNAVAILABLE will be Skipped in the FILL sequence.
- If a tank is partially full as determined by an operator adjustable level setpoint an, as indicated by water level, switch that tank to FILL mode allowing that tank to be filled first.

Once FILL mode is initiated at a specific tank, aeration at that tank will be initiated. Note: when WAS is in a tank, aeration should be operating unless tank is in DECANT mode.

Filling of a specific tank will stop once water level in the tank reaches an operator set point (initially set at X) or a stop FILL signal is received based sufficient volume wasted. After filling stops, PLC will switch status of that tank to HOLD.

If all tanks are marked as unavailable or are filled before the indicated wasting volume is achieved, PLC will close the influent valve(s).

A tank cannot be called for FILL and DRAW simultaneously unless no other tanks are available.

DRAW Mode:

- Initiated by the Solids Handling Process: Belt Filter Presses (Exiting "P" Series Controls) must be operating. DRAW rate of flow shall equal feed rate of flow to Belt Filter Presses.
- Tanks will be emptied in sequence based on an operator defined sequence, initially set at 1, 2, 3)

- Operator will have the option to mark a tank or tanks as “UNAVAILABLE”. If a tank is UNAVAILABLE, skip that tank in the DRAW sequence.

Emptying of a specific tank will stop once water level in the tank reaches an operator set point (initially set at X ft). After emptying stops, PLC will mark that tank as available for FILL

If all tanks are marked as UNAVAILABLE or empty when a system start call from the Solids Handling Process is received, a FAIL signal will be sent to the Solids Handling Process and initiate an immediate Solids Handling System STOP.

A tank cannot be called for FILL and DRAW simultaneously unless no other tanks are available.

HOLD Mode:

- Initiated upon completion of a tank FILL Mode, a stop FILL signal from the WASTING RATE control loop, or a stop DRAW signal from the Solids Handling Process leaving a tank partially full.

- Once HOLD mode is initiated at a specific tank, WAS Aeration at that tank will be initiated (with operator option to override and stop aeration)

DECANT Mode

- Initiate after operator confirms that water level in tank to be decanted is above the level of the decant valves, close influent valve to tank that will be decanted.

- Tank will be flagged as UNAVAILABLE to prevent any other control loop being able to FILL or DRAW from the selected tank

- Close draw valve at bottom of tank to be decanted, (51-V-04-WAS, 51-V-05-WAS, or 51-V-06-WAS)

- Stop WAS Aeration air to tank that will be decanted

- Open one of the three decant valves provided for each tank.

Operational experience is expected to guide operator regarding the settling time needed after cessation of aeration before opening a decant valve. Experience will also guide operator in how long decant valve should be opened, and which decant valve should be used (upper, middle, lower valve).

SCADA screen should display water levels in all three WAS storage tanks to aid manually decanting of the tanks

WAS DEWATERING MODE SELECTION

General: WAS Storage Tanks shall include new SCADA based provisions for two new modes of dewatering operations allowing the existing belt filter presses to pull WAS from one of two sources: 1) Off of existing RAS line (this is current operation) or 2) from WAS tanks.

Description: Provide HMI resident switch for Mode selection by the Operator from the Plant SCADA HMI.

- Mode 1 – WAS from RAS Line
    - Existing Valves at Headworks
        - 12-V-01-RAS – Open
        - 12-V-02-RAS – Open
        - 12-V-01-WAS – Open
    - New Valves at WAS Storage Tank
        - 51-V-04-WAS - Closed
        - 51-V-05-WAS - Closed
        - 51-V-06-WAS - Closed
- Mode 2 - WAS from WAS Storage Tanks
    - Existing Valves at Headworks
        - 12-V-01-RAS – Closed
        - 12-V-02-RAS – Closed
        - 12-V-01-WAS – Closed
    - New Valves at WAS Storage Tank – one of the three must be open as selected by the operator based on tank conditions
        - 51-V-04-WAS
        - 51-V-05-WAS
        - 51-V-06-WAS

WAS AERATION SYSTEM CONTROL

General: Controls air flow to the WAS Storage Tanks based on tank level.

Description: Air from positive displacement blowers (51-B-01-AA and 51-B-02-AA) is delivered to each tank through coarse bubble diffusers. Air flow from the blowers is monitored by a flowmeter at each tank (51-FE/FIT-N7, 51-FE/FIT-N8, and 51-FE/FIT-N9) and is regulated by a modulating butterfly valve(51-V-01-AA, 51-V-02-AA, and 51-V-03-AA) for throttling of the air to each tank. The motorized butterfly valves are normally controlled automatically based on water level as measured by hydrostatic pressure near the bottom of each tank. Air flow will increase linearly with water level. Air flow is to be provided to all tanks with a water level above a minimum value adjustable as set by the operator except when a given tank is in DECANT mode. In this case, no air flow should be provided to that tank.

LOOP 51-N1

WAS Storage Flowmeter and Solids Analyzer (51-FE/FIT-N1 and 51-AE/AIT-N1)

P&ID: 51-I-01

Description:

Measure WAS flow and total suspended solids in the incoming WAS stream

Control:

Field:

None

Local (MCC):

None

Remote (HMI at SCADA Central):

As described in General WAS Control Schemes

Power Failure State

Not Applicable

Alarms and Monitoring:

Field:

Flow (FIT)

Total Suspended Solids (AIT)

Local (MCC):

None

Remote (HMI at SCADA Central)

Flow (FIT)

Total Suspended Solids (AIT)

LOOP 51-N2

WAS Storage Tank 1 Inlet Valve (51-V-01-WAS)

P&ID: 51-I-01

Description:

WAS Inlet valve is used to fill WAS Tank No. 1 under the control mode selected by the operator.

Control:

Field:

LOCAL-OFF-REMOTE Selector (HS-1)
OPEN Pushbutton (HS-2)
STOP Pushbutton (HS-3)
CLOSE Pushbutton (HS-4)

Remote (HMI at SCADA Central):

Auto-Manual HMI Selector (HS-M)
In Auto:
Control of inlet valve shall be determined by operational mode selected by the Operator
Valve Position Control (%) (ZIC)
In Manual:
Valve Open HMI Pushbutton (HS-D)
Valve Close HMI Pushbutton (HS-E)

Power Failure State

Valves shall fail Closed, Manual Reset to operational mode after restoration of power

Alarms and Monitoring:

Field:

Full Open (ZLH)

Full Closed (ZLL)

Remote (HMI at SCADA Central)

In Remote (REMOTE)

Full Open (OPEN)

Full Closed (CLOSE)

Position (%)

LOOP 51-N3

WAS Storage Tank 2 Inlet Valve (51-V-02-RAS)

P&ID: 51-I-01

Functionally identical to Loop 51-N2

LOOP 51-N4

WAS Storage Tank 3 Inlet Valve (51-V-03-WAS)

P&ID: 51-I-01

Functionally identical to Loop 51-N2

LOOP Series 51: WAS AERATION BLOWERS

General: The WAS blower system provides air to the coarse bubble diffuser system in each tank. Blower manufacturers shall also supply the flowmeters, and control valving that control air flow into each tank. By requiring blower manufacturers to supply a complete blower and aeration control system, blower manufacturers will have the responsibility for delivering a complete, programmed, and functioning aeration system.

Description:

There is one duty and one standby rotary lobe positive displacement blower located at the WAS storage tanks. Each blower is sized to deliver a maximum of 1,620 scfm to keep solids mixed and in suspension and to prevent generation of odors by delivering oxygen to the stored WAS. Each blower must also be able to deliver a minimum of 540 scfm while maintaining an acceptable efficiency without surging.

Blowers in Auto mode shall operate in lead/lag operation with first on/first off sequencing. The blowers shall be equipped with ASDs to control speed/air flow rate.

The air control valves at each WAS tank will control rate of air flow proportional to depth of water in the tank served by the air control valve. Minimum rate of flow at minimum water depth shall be adjustable by operator. Maximum rate of air flow at maximum water depth shall be adjustable by operator.

Blower speed shall vary to maintain air pressure in the common air header feeding all three WAS tanks. Pressure in common header shall be that needed to supply the required air flow to the tank with the highest water level. (Maintaining this pressure in the common air header will also ensure sufficient pressure and air flow to tanks that have lower water levels.) Lag blower shall be brought on line if needed to maintain needed air pressure in common air header, or if operator adjustable maximum speed on lead blower is exceeded.

An operator adjustable time delay shall control the frequency of the blower speed adjustments and the initiation of lag blower operator. An operator adjustable minimum speed setpoint shall be used to start lead blower. When two blowers are operating, their speeds shall be adjusted to operate at same speed.

The blower shall be in faulted status when the blower run is at fault, motor over temperature, ASD fault, discharge high pressure, or discharge low pressure.

LOOP 51-N5

WAS Storage Mixing Blower 1 (51-B-01-AA)

P&ID: 51-I-01

Description:

Control:

Field:

None.

Local (51-CS-05):

Local/Remote – In Local, blower shall run at manually entered speed at ASD HMI

Start (HS-2)

Stop (HS-3)

Speed – Blower speed/air flow rate control for Hand mode (50% to 100%) (HSK)

Remote (MCC):

Reset – Resets latched ASD alarm conditions to normal

ASD On/Off from ASD HMI

Speed – Blower speed/air flow rate control for Hand mode (50% to 100%) from ASD HMI

High Temp Shutdown (TSH)

High Pressure Shutdown (PSH)

Local and Remote (HMI – SCADA Central):

Hand/Off/Auto – When Hand/Off/Auto switch is in Auto position, the blower shall run based on Operator selected Operational Mode

CALL

Speed Control (SPEED)

Alarms and Monitoring:

Field:

None

Local (51-CS-05):

ON (YL-1)

OFF (YL-2)

Speed Indication (SI)

Remote (MCC):

ASD ON (YL-3)

Speed – ASD HMI

Over Temp (TLH)

High Pressure (PLH)

ASD Fail (ULA)

Local and Remote (HMI – PPP and SCADA Central)

Remote (REMOTE)\

ASD On (RUN)

Speed (%)

Temperature High (TAH)

Pressure High (PAH)

ASD Fail (FAIL)

LOOP 51-N6

WAS Storage Mixing Blower 2 (51-B-02-AA)

P&ID: 51-I-01

Functionally identical to Loop 51-N5

LOOP 51-N7

Storage Tank 1 Air Flow (51-N7)

P&ID: 51-I-01

Description:

Flow meter monitors Aeration Air into WAS Tank 1. Control Variable for Aeration Modulating Valve (51-V-01-AA)

Control:

Field:

None

Remote (HMI at SCADA Central):

WAS Aeration Control variable

Power Failure State

Not Applicable

Alarms and Monitoring:

Field:

None

Remote (HMI at SCADA Central)

Flow (FIT)

LOOP 51-N8

Storage Tank 2 Air Flow (51-N8)

P&ID: 51-I-01

Functionally identical to Loop 51-N7

LOOP 51-N9

Storage Tank 3 Air Flow (51-N9)

P&ID: 51-I-01

Functionally identical to Loop 51-N7

LOOP 51-N11

WAS Storage Tank 1 Decant Effluent Valve 1 (51-V-01-DEC)

P&ID: 51-I-01

Description:

WAS Decant valve is used in Decant mode to pull decant liquid from WAS Tank No. 1 under the DECANT control mode selected by the operator.

Control:

Field:

LOCAL-OFF-REMOTE Selector (HS-1)
OPEN Pushbutton (HS-2)
STOP Pushbutton (HS-3)
CLOSE Pushbutton (HS-4)

Remote (HMI at SCADA Central):

Manual (only):
Valve Open HMI Pushbutton (HS-D)
Valve Close HMI Pushbutton (HS-E)

Power Failure State

Valves shall fail Closed, Manual Reset to operational mode after restoration of power

Alarms and Monitoring:

Field:

Full Open (ZLH)

Full Closed (ZLL)

Remote (HMI at SCADA Central)

In Remote (REMOTE)

Full Open (OPEN)

Full Closed (CLOSE)

LOOP 51-N12

WAS Storage Tank 1 Decant Effluent Valve 2 (51-V-02-DEC)

P&ID: 51-I-01

Functionally identical to Loop 51-N11

LOOP 51-N13

WAS Storage Tank 1 Decant Effluent Valve 3 (51-V-03-DEC)

P&ID: 51-I-01

Functionally identical to Loop 51-N11

LOOP 51-N14

WAS Storage Tank 2 Decant Effluent Valve 1 (51-V-04-DEC)

P&ID: 51-I-01

Functionally identical to Loop 51-N11

LOOP 51-N15

WAS Storage Tank 2 Decant Effluent Valve 2 (51-V-05-DEC)

P&ID: 51-I-01

Functionally identical to Loop 51-N11

LOOP 51-N16

WAS Storage Tank 2 Decant Effluent Valve 3 (51-V-06-DEC)

P&ID: 51-I-01

Functionally identical to Loop 51-N11

LOOP 51-N17

WAS Storage Tank 3 Decant Effluent Valve 1 (51-V-07-DEC)

P&ID: 51-I-01

Functionally identical to Loop 51-N11

LOOP 51-N18

WAS Storage Tank 3 Decant Effluent Valve 2 (51-V-08-DEC)

P&ID: 51-I-01

Functionally identical to Loop 51-N11

LOOP 51-N19

WAS Storage Tank 3 Decant Effluent Valve 3 (51-V-09-DEC)

P&ID: 51-I-01

Functionally identical to Loop 51-N11

LOOP 51-N20

WAS Storage Tank 1 WAS Effluent Valve (51-V-04-WAS)

P&ID: 51-I-01

Description:

WAS Effluent Valve is used to drain WAS Tank No. 1 under the control mode selected by the operator.

Control:

Field:

LOCAL-OFF-REMOTE Selector (HS-1)
OPEN Pushbutton (HS-2)
STOP Pushbutton (HS-3)
CLOSE Pushbutton (HS-4)

Remote (HMI at SCADA Central):

Auto-Manual HMI Selector (HS-M)
In Auto:
Control of effluent valve shall be determined by operational mode selected by the Operator
Valve Position Control (%) (ZIC)
In Manual:
Valve Open HMI Pushbutton (HS-D)
Valve Close HMI Pushbutton (HS-E)

Power Failure State

Valves shall fail Closed, Manual Reset to operational mode after restoration of power

Alarms and Monitoring:

Field:

Full Open (ZLH)

Full Closed (ZLL)

Remote (HMI at SCADA Central)

In Remote (REMOTE)

Full Open (OPEN)

Full Closed (CLOSE)

Position (%)

LOOP 51-N21

WAS Storage Tank 2 WAS Effluent Valve (51-V-05-WAS)

P&ID: 51-I-01

Functionally identical to Loop 51-N20

LOOP 51-N22

WAS Storage Tank 3 WAS Effluent Valve (51-V-06-WAS)

P&ID: 51-I-01

Functionally identical to Loop 51-N20

LOOP 51-N23

WAS Storage Tanks RAS Influent Valve No. 1 (51-V-08-WAS)

P&ID: 51-I-01

Description:

WAS Storage Tank Main Influent Valve is controls overall WAS flow originating from the new RAS Pump Station to the storage tank as per the control mode selected by the operator.

Control:

Field:

LOCAL-OFF-REMOTE Selector (HS-1)
OPEN Pushbutton (HS-2)
STOP Pushbutton (HS-3)
CLOSE Pushbutton (HS-4)

Remote (HMI at SCADA Central):

Auto-Manual HMI Selector (HS-M)
In Auto:
Control of main WAS influent valve shall be determined by operational mode selected by the Operator
Valve Position Control (%) (ZIC)
In Manual:
Valve Open HMI Pushbutton (HS-D)
Valve Close HMI Pushbutton (HS-E)

Power Failure State

Valves shall fail Closed, Manual Reset to operational mode after restoration of power

Alarms and Monitoring:

Field:

Full Open (ZLH)

Full Closed (ZLL)

Remote (HMI at SCADA Central)

In Remote (REMOTE)

Full Open (OPEN)

Full Closed (CLOSE)

Position (%)

LOOP 51-N24

WAS Storage Tanks RAS Influent Valve No. 2 (51-V-09-WAS)

P&ID: 51-I-01

Description:

WAS Storage Tank Main Influent Valve is controls overall WAS flow originating from the existing RAS Pump Station to the storage tank as per the control mode selected by the operator.

Control:

Field:

LOCAL-OFF-REMOTE Selector (HS-1)
OPEN Pushbutton (HS-2)
STOP Pushbutton (HS-3)
CLOSE Pushbutton (HS-4)

Remote (HMI at SCADA Central):

Auto-Manual HMI Selector (HS-M)
In Auto:
Control of main WAS influent valve shall be determined by operational mode selected by the Operator
Valve Position Control (%) (ZIC)
In Manual:
Valve Open HMI Pushbutton (HS-D)
Valve Close HMI Pushbutton (HS-E)

Power Failure State

Valves shall fail Closed, Manual Reset to operational mode after restoration of power

Alarms and Monitoring:

Field:

Full Open (ZLH)

Full Closed (ZLL)

Remote (HMI at SCADA Central)

In Remote (REMOTE)

Full Open (OPEN)

Full Closed (CLOSE)

Position (%)

51-N25

Storage Tank 1 Level Sensor (51-LE/LIT-N25)

P&ID: 51-I-01

Description:

Monitors level in WAS Storage Tank 1. Used to determine characteristics of tank for establishing Operational Mode

Control:

Field:

None

Remote (HMI at SCADA Central):

Level used for WAS Storage control per the Operational descriptions above

Power Failure State

Not Applicable

Alarms and Monitoring:

Field:

Level (LIT)

Remote (HMI at SCADA Central)

Level (LIT)

LOOP 51-N26

Storage Tank 2 Level Sensor (51-LE/LIT-N26)

P&ID: 51-I-01

Description:

Functionally identical to Loop 51-N25

LOOP 51-N27

Storage Tank 3 Level Sensor (51-LE/LIT-N27)

P&ID: 51-I-01

Functionally identical to Loop 51-N27

Loop 51-N28

WAS Storage Discharge Suspended Solids Analyzer (51-AE/AIT-N28)

P&ID: 51-I-01

Description:

Measure total suspended solids in the WAS Storage Discharge stream

Control:

Field:

None

Local (MCC):

None

Remote (HMI at SCADA Central):

As described in General WAS Control Schemes

Power Failure State

Not Applicable

Alarms and Monitoring:

Field:

Total Suspended Solids (AIT)

Local (MCC):

None

Remote (HMI at SCADA Central)

Total Suspended Solids (AIT)

LOOP 51-N29

WAS Storage Tanks Drain Valve (51-V-01-D)

P&ID: 51-I-01

Description:

WAS Drain valve is used during drainage operations at the WAS Storage Tank facility.

Control:

Field:

LOCAL-OFF-REMOTE Selector (HS-1)
OPEN Pushbutton (HS-2)
STOP Pushbutton (HS-3)
CLOSE Pushbutton (HS-4)

Remote (HMI at SCADA Central):

Auto-Manual HMI Selector (HS-M)
In Auto:
Control of valve shall be determined by operational mode selected by the Operator
In Manual:
Valve Open HMI Pushbutton (HS-D)
Valve Close HMI Pushbutton (HS-E)

Power Failure State

Valves shall fail Closed, Manual Reset to operational mode after restoration of power

Alarms and Monitoring:

Field:

Full Open (ZLH)

Full Closed (ZLL)

Remote (HMI at SCADA Central)

In Remote (REMOTE)

Full Open (OPEN)

Full Closed (CLOSE)

LOOPS 52-O-XX Series

Packaged Sludge Drying System

P&ID: 52-I-01 through 52-I-09)

Description:

The new Sludge Drying system is located in the new Solids/Dryer Building. Incoming sludge is transferred via two new dewatered sludge screw conveyors (14-ME-03-DWS and 14-ME-04-DWS) to the new sludge hopper. Level in the sludge hopper is used as the basis for starting and stopping the sludge drying process. After processing, the cake solids from the Dryer System are removed via separate Dried Solids Loadout Conveyors where it is dropped into sludge hauling trailers. The entire Sludge Drying process is shown on P&ID "O" Series on sheets 52-I-01 through 52-I-09.

The control system for the Dryer System controls all other appurtenant startup and stopping steps, equipment protections, and other equipment necessary for sludge dewatering wet cake pumps, dried sludge discharge, transfer, and loadout conveyors, all other ancillary equipment as shown on the Drawing. Refer to Section 11600 for detailed loop descriptions and operations strategies for the packaged Dryer system.

Dryer system operation shall commence with sludge hopper level achieving a minimum operational level. During operation, Plant SCADA shall monitor all sludge drying processes' status and provide limited shutdowns, permissives, and interlocks for Dryer operations as follows:

- High Sludge Hopper Level High (LSHH-O10) shall shutdown all Dryer functions and also shutdown the Dewatered Sludge Conveyors and associated Belt Filter Presses

- Ventilation Fan 14-F-12-FA confirmed Running shall be a permissive for Dryer operation. Loss of Running condition shall be maintained for an operator adjustable timer period (initially set at 15 seconds. If Loss of Running persists, condition shall be alarmed, latched, and implement Dryer Shutdown.

- Remote Shutdown: Operator shall have ability to remotely shutdown the Dryer System Remotely from the SCADA Central HMI via HS-O01

- Power Failure Restart: Following power failure and restoration, Dryer shall restart after adjustable power restoration time delay.

- Network failure: Dryer system shall shutdown upon loss of network connection to SCADA Central

60-K-Series Loops

Chlorine Contact Basins

P&ID: 60-I-01

General: Controls gates at the chlorine contact basins (CCB) to allow the disinfection system to operate in either the low CT or the high CT mode. Additional sample pumps and analyzers are added for additional water quality monitoring

Description:
Existing System: A 36-inch pipe carries the filter effluent from the Tertiary Filter and reduces to 24 inch just before entering the FEF Meter Vault. Inside the meter vault, the pipe size is reduced to 20 inch diameter and passes through a magnetic flowmeter. The pipe diameter then increases to 24 inch diameter before leaving the vault. A 1-inch sodium hypochlorite feed line provides a source for disinfection at the vault. The pipe increases to 36 inch diameter after leaving the vault and discharges to the southeast corner of the Chlorine Contact Basin. A chemical induction unit is located at the inlet opening to the chlorine contact basin. This unit is used to provide mixing energy.(It is not used for hypochlorite injection.) Hypochlorite is fed through a diffuser pipe adjacent to the induction unit.

Work under this Contract:

The retrofitted CCBs (Basins 2A and 2B) can operate in 2 modes- Low CT and High CT. CCB Basin 1 can only be operated in the High CT mode. The City has received conditional acceptance of Free Chlorine Disinfection as an alternative disinfection technology to meet Title 22 disinfection requirements and help the City meet disinfection by-product limits. To utilize free chlorine disinfection, the CCB would operate in Low CT mode and would need to meet the following conditions:

- Free chlorine residual contact time ($FCRCT_{virus}$) of 9 mg-min/L as measured by AE/AIT K4-3 at all times for virus inactivation and maintain a minimum free chlorine residual (FCR) of 1.0 mg/L at the compliance point

- $FCRCT_{coliform}$ 30-50 mg-min/L as measured by AE/AIT K4-2 for total coliform requirements

- Free chlorine modal contact time of four minutes at all times

Operators manually change between the two operating modes based on ammonia concentrations in the filtered effluent and coliform counts in the disinfected effluent.

There are two chlorine contact tanks each with 3 passes- Basin No. 1 and Basin No. 2. Basin No. 2 shall be retrofitted to allow operation in the Low CT mode as well as the High CT mode. A longitudinal wall shall be added to the first pass of Basin No. 2 to create two reduced width channels (Basin 2A and Basin 2B) and gates (62-G-05-FEF and 62-G-06-FEF) shall be provided at Basin 2A and 2B. New gate 62-G-03-FEF shall be provided at the effluent end of the new channels.

Control Modes:

Existing System:

High CT- All filtered effluent flow will either flow through all three passes of Basin No. 1 or Basin No. 2. When Basin No. 1 is used, all influent and effluent gates at Basin No. 2 will be closed. Stop gate 62-G-01-FEF will be manually opened by plant staff. Gate 62-G-01-FE will open.

When Basin No. 2 is used, all influent and effluent gates at Basin No. 1 will be closed. Stop gate 62-G-02-FEF will be manually opened by plant staff. Gate 62-G-02-FE will open.

Work under this Contract:

Low CT- The disinfection system will typically operate in the low CT mode. Plant staff will manually close stop gate 62-G-01-FEF and either gate 62-G-05-FEF or 62-G-06-FEF will open to allow all flow into one of the reduced modified channels Basin No. 2A or 2B. Chlorinated effluent will flow over a weir at the end of each of the reduced width channels. Gate 62-G-03-FE will be open to allow chlorinated effluent to bypass the second and third pass of Basin No. 2. A weir at the end of the first pass will prevent chlorinated effluent from flowing into the second and third pass of basin No. 2. If 62-G-03-FE is open, provide interlock so that 62-G-02-FE and 62-G-01-FE are closed.

High CT: All filtered effluent flow will either flow through all three passes of Basin No. 1 or Basin No. 2. When Basin No. 1 is used, all influent and effluent gates at Basin No. 2 will be closed. Stop gate 62-G-01-FEF will be manually opened by plant staff. Gate 62-G-01-FE will open. Existing sampling pump 62-P-05-SA will run providing a sample source for new free chlorine Analyzer 61-AE/AIT-K4-2. All influent and effluent gates at Basin No. 2 will be closed.

When Basin No. 2 is used in High CT mode, new gates 62-G-05-FEF and 62-G-06-FEF will open and 62-G-03-FE will be closed so filtered effluent will overflow the weir between the first and second pass of Basin No. 2 and flow through the remainder of the chlorine contact tank Basin No. 2. Gate 62-G-02-FE will open and chlorinated effluent will enter the effluent channel. Existing sampling pump 62-P-02-SA will run providing a sample source for new free chlorine Analyzer 61-AE/AIT-K4-2. All influent and effluent gates at Basin No. 1 will be closed.

Sodium Hypochlorite Feed Pumps (Existing)

General: Controls sodium hypochlorite dosage to the filtered effluent entering the chlorine contact basins based on filtered effluent flow, free chlorine concentrations in the final effluent, and free chlorine concentrations of filtered effluent before entering the chlorine contact tank.

Description:

Existing sodium hypochlorite pumps in the chemical complex will feed hypochlorite from the existing hypochlorite storage tanks to the chlorine contact tank, RAS pump stations, influent wet well, and the utility water line. The control strategy for chlorine dosing to the RAS pump stations, influent wet well, and the utility water line are not anticipated to change under the Phase II expansion project.

Hypochlorite dosing to the chlorine contact tank shall be controlled to allow the chlorine contact tank to operate in either the low-CT and high-CT mode as presently configured. New sampling pumps (62-P-06-SA, 62-P-07-SA, and 62-P-08-SA) shall be provided in Basin 2A, 2B, and at the effluent to of Basins 1A and 2B respectively for providing new sampling flow to the existing chemical analyzer stations. Sampling pumps shall be turned on and off manually in the field and

flow verified with associated sample line flow switches (FSH-K21, FSH-K22, and FSH-K23).

Control Modes:

Existing System Summary

High CT:

The hypochlorite feed pumps shall be flow paced based on flow from filter effluent flow meter (FE/FIT-K2). Hypochlorite feed pump outputs shall also be adjusted to maintain a total chlorine residual setpoint in the filtered effluent as measured by AIT/AE-K1 (CT Influent). In high CT mode, provide HMI alarm should total chlorine residual fall below 0.5 mg/L (operator adjustable).

Work under this Contract

Low CT:

The hypochlorite feed pumps shall be flow paced based on flow from filter effluent flow meter (FE/FIT-K2). Hypochlorite feed pump outputs shall also be adjusted to maintain a total chlorine residual setpoint in the filtered effluent as measured by AIT/AE K1 ($CT_{Influent}$). The control shall be a proportional integral derivative (PID) cascade control loop where the $FCRCT_{virus}$ setpoint trims an inlet residual setpoint ($CT_{influent}$), which trims the flow paced sodium hypochlorite dose.

The hypochlorite feed pumps shall be flow paced based on flow from filter effluent flow meter (FE/FIT-K2). Hypochlorite feed pump outputs shall also be adjusted to maintain a total chlorine residual setpoint in the filtered effluent as measured by AIT/AE K1 (CT Influent).

$$CT_{influent}\ [\text{mg-min/L}] = Cl_{2,\ Free} * F_B * V/Q$$

Where:

$Cl_{2,\ Free,\ inf}$ [mg/L]= Free chlorine residual from AE/AIT K10

V [gal]= CCB volume at CT_{virus} compliance point =42,547 gal or 85,094 gal if both Basin 2A and 2B are in service.

Q [gpm]= filtered effluent flow from FE/FIT K2

F_B =Modal baffling factor (operator adjustable, initially set at 0.8)

The influent free chlorine analyzer is located very close to the hypochlorite injection point (20 seconds at peak wet weather flow) and this feedback loop has a short response timeframe.

$FCRCT_{coliform}$ will be calculated and displayed to determine if the target range of 30-50 mg-min/L is met. If $FCRCT_{coliform}$ is greater than 48 mg-min/L (operator adjustable setpoint), the $CT_{influent}$ set point shall be adjusted lower to decrease the hypochlorite feed rate. If $FCRCT_{coliform}$ is less than 32 (operator adjustable setpoint), the $CT_{influent}$ set point shall be adjusted higher to increase the hypochlorite feed rate. Provide alarm if $FCRCT_{coliform}$ is above 50 mg-min/L or below 30 mg-min/L. $FCRCT_{coliform}$ shall be calculated as follows:

$$FCRCT_{coliform} = Cl_{2,\ Free} * F_B * V/Q$$

Where:

$Cl_{2, Free}$ [mg/L]= Free chlorine residual from AE/AIT K4-2

V [gal]= CCB volume at compliance point =72,603 gal or 144,603 gal if both Basin 2A and 2B are in service.

Q [gpm]= filtered effluent flow from FE/FIT K2

F_B =Modal baffling factor (operator adjustable, initially set at 0.8)

$FCRCT_{virus}$ will be calculated to ensure the $FCRCT_{virus}$ maintained above 9 mg-min/L. If $FCRCT_{virus}$ is less than 12 mg-min/L (operator adjustable setpoint), the $CT_{influent}$ set point shall be adjusted higher to increase the hypochlorite feed rate. Provide alarm if $FCRCT_{virus}$ is below 30 mg-min/L. $FCRCT_{virus}$ shall be calculated as follows:

$$FCRCT_{virus} = Cl_{2, Free} * F_B * V/Q$$

Where:

$Cl_{2, Free}$ [mg/L]= Free chlorine residual from AE/AIT K4-3

V [gal]= CCB volume at compliance point =42,547 gal or 85,094 gal if both Basin 2A and 2B are in service.

Q [gpm]= filtered effluent flow from FE/FIT K2

F_B =Modal baffling factor (operator adjustable, initially set at 0.8)

The free chlorine modal contact time (FCMCT) shall be displayed at the HMI. An alarm shall be provided if free chlorine modal contact time is below 4 minutes. FCMCT is calculated as follows:

$$FCMCT = F_B * V/Q$$

Where:

V=42,547 gallons

Q [gpm]= filtered effluent flow from FE/FIT K2

F_B =Modal baffling factor (operator adjustable, initially set at 0.8)

The FCR at the virus inactivation compliance point shall be maintained above 1.5 mg/L as measured by K4-3 to ensure a minimum FCR of 1.0 mg/L at all times . If free chlorine falls below 1.5 mg/L, $CT_{influent}$ setpoint shall be increased increased. If free chlorine measured by AIT/AE K4-3 falls below 1.0 mg/L, provide HMI alarm.

Currently, the existing transmitter flow range (FE/FIT-K2) is 0.5 mgd to 10 mgd. Under the changes implemented under this project, the maximum design flow rate is 12.8 mgd for Phase II. Recalibrate and modify flow pacing control to reflect the change in plant operating range.

Provide alarm when two existing hypochlorite feed pumps are operated at maximum flowrate of 45 gph.

High CT- When total coliform or low-CT, CT residual or modal time requirements cannot be met or when excessive ammonia bleed-through occurs, the CCBs will operate in High CT mode. Operators shall manually switch between Low CT and High CT mode.

The hypochlorite feed pumps shall be flow paced based on flow from filter effluent flow meter (FE/FIT-K2). Hypochlorite feed pump outputs shall also be adjusted to maintain a total chlorine residual setpoint in the filtered effluent as measured by AIT/AE K1. In high CT mode, provide HMI alarm should total chlorine residual fall below 0.5 mg/L (operator adjustable).

Currently, the existing transmitter flow range (FE/FIT-K2) is 0.5 mgd to 10 mgd. Under the changes implemented under this project, the maximum design flow rate is 12.8 mgd for Phase II. Recalibrate and modify flow pacing control to reflect the change in plant operating range.

Provide alarm when two existing hypochlorite feed pumps are operated at maximum flowrate of 45 gph.

LOOP 60-K2

Modifications to Existing Flow Meter at Chlorine Contact Basins (60-FE/FIT-K2)

P&ID: 60-I-01

Description:

Currently, the existing transmitter flow range (FE/FIT-K2) is 0.5 mgd to 10 mgd. Under the changes implemented under this project, the maximum design flow rate is 12.8 mgd for Phase II. Recalibrate and modify flow pacing control to reflect the change in plant operating range.

Control:

Field:

None

Remote (HMI at SCADA Central):

Used for disinfection loops as described

Alarms and Monitoring:

Field:

FE/FIT - Recalibrated

Remote (HMI at SCADA Central)

FE/FIT - Recalibrated

LOOP 60-K4-2

Chlorine Contact Basins Effluent Free Chlorine Analyzer (60-AE/AIT-K4-2)

P&ID: 60-I-01

Description:

Measures free chlorine residual at effluent of Chlorine Contact Tank Basins 2A and 2B.

Control:

Field:

None.

Remote (HMI at SCADA Central):

Control loops modified for free chlorine addition as described.

Alarms and Monitoring:

Field:

Free Chlorine Residual (AE/AIT)

Remote (HMI at SCADA Central)

Free Chlorine Residual (AE/AIT)

LOOP 60-K4-3

Chlorine Contact Basins Channels Free Chlorine Analyzer (60-AE/AIT-K4-3)

P&ID: 60-I-01

Description:

Measures free chlorine residual at new chlorine contact channels made by the addition of new gates 62-G-05-FEF and 62-G-06-FEF in Chlorine Contact Basins and sample pump operation (62-P-07-SA and 60-P-08-SA). Correlate free chlorine reading with gate positions and sample pump operation per flow switches FSH-K22 and FSH-K23 respectively.

Control:

Field:

None.

Remote (HMI at SCADA Central):

Control loops modified for free chlorine addition as described.

Alarms and Monitoring:

Field:

Free Chlorine Residual (AE/AIT)

Remote (HMI at SCADA Central)

Free Chlorine Residual (AE/AIT)

LOOP 60-K10

Chlorine Contact Basins Influent Free Chlorine Analyzer (60-AE/AIT-K10)

P&ID: 60-I-01

Description:

Measures free chlorine residual at influent to Chlorine Contact Basins

Control:

Field:

None.

Remote (HMI at SCADA Central):

Control loops modified for free chlorine addition as described.

Alarms and Monitoring:

Field:

Free Chlorine Residual (AE/AIT)

Remote (HMI at SCADA Central)

Free Chlorine Residual (AE/AIT)

LOOP 60-K10

Chlorine Contact Basins Free Chlorine Analyzer Sample Pump Flow (60-FSH-K10)

P&ID: 60-I-01

Description:

Monitors operation of existing sample pump 62-P-04-SA for sample line to new free chlorine residual analyzer AE/AIT-K10) at influent to Chlorine Contact Basins

Control:

Field:

Existing pump manual ON/OFF local control

Remote (HMI at SCADA Central):

None

Alarms and Monitoring:

Field:

None

Remote (HMI at SCADA Central)

Sample Pump Fail (FAH)

LOOP 60-K12

Chlorine Contact Basin 2 Influent Gate (62-G-05-FEF)

P&ID: 60-I-01

Description:

New Gate added to create new chlorine Contact Basin Channel.

Control:

Field:

LOCAL-OFF-REMOTE Selector (HS-1)
OPEN Pushbutton (HS-2)
STOP Pushbutton (HS-3)
CLOSE Pushbutton (HS-4)

Remote (HMI at SCADA Central):

Auto-Manual HMI Selector (HS-M)
In Auto:
Control of gate shall be determined by operational mode selected by the Operator
In Manual:
Valve Open HMI Pushbutton (HS-D)
Valve Close HMI Pushbutton (HS-E)

Gate position shall be correlated with sample pump operation (62-P-08-SA and flow switch (FSH-K23) for confirming sample free chlorine monitoring

(AE/AIT-K4-3) for disinfection loops.

Power Failure State

Gates shall remain in current state

Alarms and Monitoring:

Field:

Full Open (ZLH)

Full Closed (ZLL)

Alarm if both Chorine Contact Basin gates 5 (62-G-05-FEF) and (62-G-06-FEF) are both open in Low CT mode.

Remote (HMI at SCADA Central)

In Remote (REMOTE)

Full Open (OPEN)

Full Closed (CLOSE)

LOOP 60-K14

Chlorine Contact Basin 2 Influent Gate (62-G-06-FEF)

P&ID: 60-I-01

Description:

New Gate added to create new Chlorine Contact Basin Channel.

Functionally equivalent to gate 62-G-05-FEF, Loop 60-K12

LOOP 60-K16

Chlorine Contact Basin 2 Reduced Channel Effluent Gate (62-G-03-FE)

P&ID: 60-I-01

Gate opens upon activation of either new Chlorine Contact Basin inlet Gates 62-G-05-FEF or 62-G-06-FEF in Low CT mode. If 62-G-03-FE is open, provide interlock so that 62-G-02-FE and 62-G-01-FE are closed.

If CCB is operated in High CT mode, provide an interlock to close 62-G-03-FE.

Control:

Field:

LOCAL-OFF-REMOTE Selector (HS-1)
OPEN Pushbutton (HS-2)
STOP Pushbutton (HS-3)
CLOSE Pushbutton (HS-4)

Remote (HMI at SCADA Central):

Auto-Manual HMI Selector (HS-M)
In Auto:
Control of gate shall be determined by operational mode selected by the Operator
If 62-G-03-FE is open and CCB is in Low CT mode, provide interlock so that 62-G-02-FE and 62-G-01-FE are closed.

In Manual:
Valve Open HMI Pushbutton (HS-D)
Valve Close HMI Pushbutton (HS-E)

Power Failure State

Gates shall remain in current state

Alarms and Monitoring:

Field:

Full Open (ZLH)

Full Closed (ZLL)

If CCBs are operated in High CT mode, alarm if gate is Open. If either inlet gate is open, effluent gate must be closed.

If CCBs are operated in Low CT mode, alarm if gate is closed.

Remote (HMI at SCADA Central)

In Remote (REMOTE)

Full Open (OPEN)

Full Closed (CLOSE)

LOOP 60-K18

Chlorine Contact Basin 1 Influent Gate (62-G-08-FEF)

P&ID: 60-I-01

Description:

New Gate added to existing Chlorine Contact Basin Channel. Gate shall open when CCBs are operated in high CT mode and CCB No. 1 is not in use. If CCB is operated in low CT mode, provide an interlock to close 62-G-08-FEF. If CCBs are operated in High CT mode and 62-G-05-FEF and 62-G-FEF are open, provide interlock to close 62-G-08-FEF.

Controls, Alarms and monitoring are equivalent to gate 62-G-05-FEF, Loop 60-K12

LOOP 60-K21

Chlorine Contact Basin 2 Effluent Sample Pump (62-P-06-SA)

P&ID: 60-I-01

Description:

Sample pump for providing sample source for new free chlorine analyzer AEAIT-K4-2 from effluent end of new chlorine contact basin 2 channels created with installation of new Gates 62-G-05-FEF and 62-G-06-FEF.

Control:

Field:

Existing pump manual ON/OFF local control

Remote (HMI at SCADA Central):

None

Alarms and Monitoring:

Field:

None

Remote (HMI at SCADA Central)

Sample Pump Fail (FAH)

LOOP 60-K22

Chlorine Contact Basin 2 Channel Influent Sample Pump (62-P-07-SA)

P&ID: 60-I-01

Description:

Sample pump for providing sample source for new free chlorine analyzer AEAIT-K4-3 from new chlorine contact basin 2 channel created with installation of new Gate 62-G-06-FEF.

Functionally equivalent to Sample Pump 62-P-06-SA, Loop K21

LOOP 60-K23

Chlorine Contact Basin 2 Channel Effluent Sample Pump (62-P-08-SA)

P&ID: 60-I-01

Description:

Sample pump for providing sample source for new free chlorine analyzer AEAIT-K4-3 from influent end of new Chlorine Contact Basin 2 channel created with installation of new Gate 62-G-05-FEF.

Functionally equivalent to Sample Pump 62-P-06-SA, Loop K21

LOOP 61-I3

Filter Feed Pump 3 (61-P-03-SE)

P&ID: 61-I-01

Description:

Add a fifth Filter Feed Pump to existing filter basin.

Control:

Field:

None

Local (61-LP-01): Operator controls Filter Feed Pump ON/OFF and speed when in Local mode.

- LOCAL/REMOTE (HS-1) in LOCAL
- START/STOP (HS-2/HS-3)
- SPEED (HSK)

Remote (ASD): Operator may control Filter Feed Pump speed when 36-CS-01, HS-1 is in REMOTE

- ASD ON/OFF and Speed Control via ASD HMI
- ASD Alarm RESET (HS-5)
- ASF BYPASS (HS-1)

  Bypass contactors are included with the drives to allow across-the-line starting. When selected BYPASS and REMOTE, provide manual START/STOP control from the HMI or locally. Automatic control using the bypass contactors is not provided and control shall be in Manual (Local or Remote) mode only.

Remote (HMI at SCADA Central): Incorporate the third Filter Feed Pump into the existing Filter Feed Pump level based controls

- ASD Pump Call (CALL)
- Speed Control (%)
- Bypass Call (CALL)

Power Failure State:

- Restart after adjustable time delay following restoration of power

Alarms and Monitoring:

Field:

None

Local (61-LP-01)

- ON/OFF Status (YL-1/YL-2)
- Speed Indication (SI)

Remote (ASD):

- ASD ON Status (YL-3)
- ASD FAIL (ULA)
- ASD High Temp (TLH)
- Seal Leak (MLH)
- Bypass On (YL-4)

Remote (HMI at SCADA Central):

- ASD In Remote (REMOTE)
- ASD On (ON)
- ASD Speed indication (%)
- ASD High Temp (TAH)
- Seal Leak (MAH)
- ASD Fail (Fail)
- Bypass On (ON)

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SECTION 13490 – COMMISSIONING OF PROCESS CONTROL SYSTEMS

PART 1 GENERAL

1.1 DESCRIPTION

A. A single Process Control System Integrator (PCSI) shall furnish all services and equipment for the City of Brentwood WWTP Expansion controls, local communication networks, local interfaces to remote communication networks, and project field instrumentation as specified herein.

B. The Contract Documents are a single integrated document, and as such all Divisions and Sections apply. It is the responsibility of the CONTRACTOR and Subcontractors to review all sections to insure a complete and coordinated project.

1.2 SCOPE OF WORK

A. The PCSI testing and commissioning work shall include the following:

1. Provide all materials, equipment, labor, and services required to perform the testing and commissioning as specified in Part 3 of this Specification. Testing shall be coordinated and performed to match the Project sequence of construction.

2. No testing shall be performed until the associated testing procedures have been favorably reviewed by the Engineer.

3. Factory Testing – Fabrication/Logical (Unwitnessed and Witnessed), Operational Readiness Testing, and Functional Acceptance Testing shall be witnessed and signed off by the Engineer. No testing activities will be considered completed until witnessed, approved, and signed off by the Engineer.

4. The Contractor shall provide a minimum of four weeks' notice prior to performing witnessed factory tests. The Contractor shall provide a minimum of two weeks' notice prior to performing any witnessed field tests. The testing notification shall include the type of testing that will be performed, a detailed schedule of the testing to be performed, a list of equipment and process control loops that will be included in the testing, and a description of any treatment plant operations that will be affected.

1.3 RELATED WORK

A. As specified in Section 13400.

1.4 SUBMITTALS

A. General

1. Shop drawings shall be submitted as specified in Section 01340 and Section 13400. They shall be complete; giving equipment specifications, details of connections, wiring, ranges, installation requirements, and specific dimensions. Submittals consisting of only general sales literature will not be acceptable.

B. Submittal Requirements: Separate submittals shall be made for:

1. Testing Plan

2. Test Documentation

C. Testing Plan

1. Test Procedure Submittals: Submit the procedures proposed to be followed for each test. Procedures shall include test descriptions, forms, and checklists to be used to control and document the required tests. Include sign-off forms for each testing phase or loop (per the Specifications) with sign-off areas for the PCSI, the Owner, and the Engineer. Refer to Part 3 of this Section for testing requirements. Submit separate procedures for each specified test phases including:

a. Unwitnessed Factory Test (UFT)

b. Witnessed Factory Test (WFT)

c. Operational Readiness Test (ORT)

d. Functional Acceptance Test (FAT)

e. 30-Day Acceptance Test.

D. Test Documentation: Upon completion of each required test, document the test by submitting a copy of the signed off test procedures. Testing shall not be considered complete until the signed-off test procedures have been submitted and favorably reviewed. Submittal of other test documentation, including “highlighted” I/O electrical schematic wiring diagrams with field technician notes are not acceptable substitutes for the formal test documentation.

1.5 TESTING AND COMMISSIONING WORKSHOPS

A. The PCSI shall schedule and hold a mandatory testing and commissioning control system Coordination Workshop. The workshop shall include as a minimum the Owner, the Engineer, the Contractor, the PCSI's Project engineer, and electrical subcontractor. Owner staff shall include construction managers, technicians, operators, and maintenance staff as required. The Owner shall determine which staff members will attend each workshop. Workshops shall all be held at the City’s WWTP.

B. Schedule the Commissioning Workshops a minimum of two weeks prior to the workshop date and include a draft agenda at the time of the request for review. Within one week subsequent to each workshop, submit draft workshop minutes for review and comment; submit final minutes incorporating any comments as necessary. The PCSI shall be responsible for facilitating the workshop and providing presentation material to all participants. The PCSI and Contractor shall document the proceedings of the Coordination Workshops and submit along with all materials used at the workshop.

C. Workshop

1. Project On-Site Testing, Training, Startup & Commissioning Workshop: Following successful completion of the PCSI Factory Testing but prior to startup of the main control panel and first set of pump control panels, PCSI shall conduct a four (4) hour workshop. The intent of this workshop is for the PCSI and Contractor to provide a review of the project schedule and project execution regarding testing, startup, and training as follows:

   a. On Site Testing: Summarize the schedule for each stage of field testing and identify the teams that will be responsible for the testing. The PCSI and Contractor shall prepare a summary of how all the testing will be performed, documented, and submitted. Draft test forms as specified herein shall be presented at the workshop.

   b. Training: The PCSI and Contractor shall provide a listing of all the scheduled training that will take place with anticipated dates in accordance with these Specifications. The PCSI and Contractor shall also prepare a summary of personnel and qualifications of the individuals responsible for the training. Also indicate the target audience for the training. Any off-site training should be coordinated with the Owner staff at least 30 days prior to training.

   c. Startup: The PCSI and Contractor shall coordinate startup and integrate into the startup plan. The PCSI and Contractor shall provide the draft startup plan including schedule for the startup and the personnel responsible for the startup. The plan shall be reviewed by and coordinated with the Owner operations, technical, and engineering staff to accommodate Owner operational requirements. The PCSI and Contractor shall be responsible for the preparation of all documentation that will be used for the startup testing and verification as specified herein.

   d. Commissioning: Contractor shall review the Commissioning plan and provide status of required deliverables including but not limited to:

      1) O & M's

      2) Spare Parts

      3) Warranties

      4) Service Agreements

      5) Special equipment and tools

2. As required workshops: Five additional workshops shall be included for this project over and above the five workshops defined above. Topics and scheduling of these five additional workshops shall be solely at the discretion of the Owner to address additional project requirements that may arise during construction. Attendance at the five additional workshops shall include at a minimum the Contractor, electrical subcontractor, PCSI, and Owner representatives. Duration of each workshop shall be determined by the topic and discussion points but assume each additional workshop shall be 8 hours in length. Specific personnel required for the workshops shall be determined based on the workshop topics to be addressed. Owner shall provide a minimum of 2 weeks notice to the PCSI of

the need for the workshop after which the PCSI shall prepare a workshop agenda, coordinate workshop schedule, and facilitate the workshop.

1.6 TEST EQUIPMENT

A. Test and calibration equipment used by the PCSI during startup, testing, and commissioning shall have NIST traceable calibration. Copies of the current calibration certificates will be maintained on site by the PCSI's project manager for all instrumentation in use by the PCSI's technical staff.

PART 2 PRODUCTS (NOT USED)

PART 3 EXECUTION

3.1 TESTING

A. General

1. As part of the requirement of this Specification Section, it is the responsibility of the PCSI to provide a complete operational control system. Confirmation of an operational control system is dependent upon results derived from test procedures as specified in this Section.

2. Perform factory testing prior to shipment of the equipment and testing of the equipment once installed in the field. Once the system is in operation, an additional 30-Day Acceptance Test is required.

3. Each test shall be in the cause and effect format. The person conducting the test shall initiate an input (cause) and upon the system's or subsystem's producing the correct result (effect), the specific test requirement will have been satisfied.

4. All tests shall be conducted in accordance with prior Engineer approved procedures, forms, and checklist all as submitted by the PCSI under Part 1 of this Specification. Each test to be performed shall be described and a space provided after it for signoff by the appropriate parties after its satisfactory completion. Include "punchlist" forms with the test procedure to document issues that arise during the testing. Punchlist forms shall include a resolution section that allows a description of the correction and signoff areas for PCSI and Engineer.

5. Copies of the sign off test procedures, forms and checklists will constitute the required test documentation. The test result forms shall be submitted to Engineer for approval at the completion of each test.

6. Provide all special testing materials and equipment. Wherever possible, perform tests using actual process variables, equipment, and data. Where it is not practical to test with real process variables, equipment, and data, provide suitable means of simulation. Define these simulations techniques in the test procedures.

7. The PCSI shall coordinate all required testing with the Contractor, all affected Subcontractors, and the Engineer.

8. The PCSI shall furnish the services of field service engineers, all special calibration and test equipment and labor to perform the field tests.

9. Engineer reserves the right to test or retest all specified functions, whether or not explicitly stated on the Test Procedures, as required to determine compliance with the functional requirements of the overall system. Such testing required to determine compliance with the Specified requirements shall be performed at no additional cost to the City. Engineer's decision shall be final regarding the acceptability and completeness of all testing.

10. No equipment shall be shipped until the Engineer has received all test results and approved the system is ready for shipment.

B. Testing Sequence

1. General: The Project has been divided into construction phases. The control system testing sequence shall be coordinated with the commissioning sequence of the plant process equipment. It is the responsibility of the PCSI to coordinate and schedule testing and commissioning required to meet the project schedule. Testing shall be performed in the following sequence.

2. Factory Testing shall be performed at the PCSI fabrication shop facility or at a local facility provided under this Contract within 120 miles of the Owner's headquarters whichever is closer.

3. Factory Testing shall be performed with all system control panels, HMIs, network equipment, and communication media in place and functional. All system programming shall be completed for PLC control logic, HMI graphic, network addressing (conforming to Owner addressing requirements) so that the Factory Tests are completed and verifying that all system components and elements are operating properly and as specified prior to being shipped to the site.

4. Operational Readiness Test (ORT) and Functional Acceptance Test (FAT)

5. The 30-day Acceptance Test shall apply

C. Factory Testing shall be performed with all system control panels, HMIs, network equipment, and communication media in place and functional. All system programming shall be completed for PLC control logic, HMI graphic, network addressing (conforming to Engineer addressing requirements) so that the Factory Tests are completed and verify that all system components and elements are operating properly and as specified prior to being shipped to the site.

1. Perform both Fabrication and Logical Factory Testing as specified.

2. All control panels provided or modified under the requirements of the related technical Specification Sections of Division 13 shall be included in these tests.

3. Submit summary results of UFT including certified statement of successful completion of all UFT tasks.

D. Upon successful completion of the Factory Tests, the PCSI shall coordinate shipping or storage of the system elements as required by the Contractor and as specified to coordinate delivery of control system equipment to the site with the installation and commissioning of the electrical and mechanical equipment and as physical space is made available at the WWTP.

E. Operational Readiness Test (ORT) and Functional Acceptance Test (FAT) shall be completed through the FAT on the new Contractor provided panels and HMI. Successful FAT control system field testing shall be completed prior to any control system operation of the process equipment. Testing of panels shall include full confirmation of successful communication to and from the SCADA system on all communication channels and media as well as verification of all remote control, failover, and monitoring logic. Testing shall include verification by the PCSI of all SCADA HMI addressing. Testing shall be scheduled and coordinated with the Engineer as specified in these Specifications. Testing shall include 100% checking all new data points to and from the WWTP SCADA system.

F. The 30-day Acceptance Test shall apply to each major process system as they are brought on line. Perform a final 30-day Acceptance Test of the complete system after the successful startup of each interim phase system.

G. Unwitnessed Factory Test (UFT) – Fabrication

1. The entire system except for primary elements, final control elements, and field mounted transmitters shall be interconnected and tested to ensure the system will operate as specified. All analog and discrete input/output points not interconnected at this time shall be simulated to ensure proper operation of all alarms, monitoring devices/functions and control devices/functions.

2. All panels, consoles and assemblies shall be inspected and tested to verify that they are in conformance with related submittals, Specifications, and Drawings. During the tests, all digital system hardware and software shall be operated for at least five Days continuously without a failure to verify the system is capable of continuous operation.

3. Tests to be performed shall include but not be limited to the following. Each of these tests shall be specifically addressed in the Test Procedure submittal.

   a. 100% wiring and database address verification of panel components and process controller I/O as applicable.

   b. Demonstrate the data communication network, Ethernet, and protocols for transmission and receipt of data.

   c. Demonstrate all system software functions specified including system heartbeats, clock synchronization, and data export to other application platforms.

   d. Generate reports using test data.

   e. Test system recovery from failure scenarios including cold boot, warm boot, communication loss, power failure, process failure, redundancy backup systems, etc.

   f. Other tests as necessary to verify complete functionality of the entire control system.

H. Unwitnessed Factory Test (UFT) – Logical

1. Perform logical testing of the PLC panel developed PLC logic and associated HMI graphic screens.

2. Demonstrate analog scaling and analog alarms for analog variables on the HMI screens; verify status of all discrete variables on the HMI screens.

3. Simulate and demonstrate functionality of the process controls in conformance with the process control loop descriptions. Simulate operating conditions to verify the performance of the monitoring and control functions. Simulate functionality of permissives and logic by the new programs.

4. Demonstrate by simulating control loop response on loss of process signals from analog instrumentation, failure of controlled equipment to respond to PLC commands.

5. Demonstrate by simulating control loop response on loss of communications to other associated PLC systems or on loss of remote I/O. Confirm that output signals fail to the correct value based on the requirements of the Process Control Descriptions.

6. Demonstrate graphical user interfaces (hardware and software) for process controllers and HMI.

I. Witnessed Factory Test (WFT): Fabrication and Logical

1. Repeat the same series of tests as for the UFT but in the presence of the Engineer. All elements of the WFT shall be witnessed by the Engineer. Provide two weeks schedule notification to the Engineer prior to performing the WFT. The WFT shall not be held until after favorable review of all hardware, software, and test procedure submittals as specified in these Specifications and successful completion of the UFT.

2. Submit WFT results for review by Engineer.

J. Field Testing – Following installation of the process control system components and conforming to the testing sequence described above perform the following:

1. Operational Readiness Test (ORT)

a. General: Prior to startup and the Functional Acceptance Test, the indicated system elements shall be certified (inspected, wired, calibrated, tested, and documented) that it is installed and ready for the ORT as defined below.

b. Loop/Component Inspections and Tests: System shall be checked for proper installation, calibrated and adjusted on a loop-by-loop and component-by-component basis to ensure that it is in conformance with related submittals and these Specifications. PID loop tuning shall be completed as specified in these Specifications. Related loops shall be tested as a system to verify interlocks, operations of functionally related loops, etc.

c. The Loop/Component Inspections and Tests shall be implemented using PCSI developed, Engineer-approved forms and checklists. Each loop of functionally related group of loops (subsystem) shall have a Loop/Subsystem Status Report to organize and track inspection, adjustment and calibration. These reports shall include the following information and check off items with spaces for sign off by the system supplier:

1) Project Name, Test Date, PCSI Name, and Lead PCSI Technician Name

2) Loop Number or Loops Numbers of a Tested Subsystem

3) Tag Number for each component.

4) Check offs/signoffs for each component:

5) Tag/identification (Loop or Subsystem name)

6) Installation

7) Termination – wiring and tubing

8) Scale, Range, and Setpoint as applicable

9) Calibration/adjustment (4 point for analog, set point for switches) rising and falling

10) Check offs/signoffs for the loop

11) Panel interface terminations

12) I/O interface terminations

13) Inputs/Outputs operational: received/sent, processed, adjusted

14) Total loop operation and operation of subsystem associated loops per Section 13482.

15) Space for comments

d. The PCSI shall maintain the Loop Status Reports sheets at the job site and make them available to the Engineer at any time.

e. These inspections, calibrations, and tests do not require witnessing. However, Engineer shall review Loop Status Sheets and spot-check the PCSI test process periodically. Any deficiencies found shall be corrected by the PCSI prior to commencement of the Functional Acceptance Test.

f. Submit ORT results for review by Engineer.

2. Functional Acceptance Test (FAT).

a. General: Prior to startup, the installed instrument and control system elements as described above shall be certified that it is ready for operation. A witnessed FAT shall be performed on the system to demonstrate that it is operating and in compliance with these Specifications. All preliminary testing, inspection, and calibration shall be complete as defined in the Operational Readiness Test.

b. Each specified function and process control shall be demonstrated on a paragraph-by-paragraph, loop-by-loop, panel-by-panel, and site-by-site basis. FAT shall be correlated to the functional verification of the process control descriptions of Section 13482 addressing specific elements of overall system and sub-system control.

c. PCSI shall perform network testing for each network segment including equipment provided in other sections of the Contract Document. Test and coordinate operation of the network. Testing shall include performance and error tracking using standard network administration software. Testing shall confirm that network performance meets or exceeds the system and network performance criteria developed by the PCSI and as specified in these Specifications.

d. Loop-specific and non-loop-specific tests shall be the same as specified under Factory Tests except that the system shall be tested and all functions demonstrated using live field based data to the greatest extent possible. In addition, related loops shall be tested as a system to verify interlocks, operations of functionally related loops, etc., all as specified in Section 13482.

e. Updated versions of the documentation specified to be provided for during the Factory Tests shall be made available to Engineer at the job site during the tests. In addition, one copy of all O & M Manuals shall be available for reference at the job site during testing.

f. Following initial startup, the control system shall operate for a continuous 100 hours without failure before this test will be started. Network testing and performance testing shall be on-line and monitoring network operation throughout the 100-hour period.

g. Punchlist items and resolutions noted during the test shall be documented on the Punchlist/Resolution form. In the event of rejection of any part or function test procedure, the PCSI shall perform repairs, replacement, and/or retest within 10 Days.

h. Submit FAT results for review by the Engineer.

3. 30-Day Acceptance Test

a. After completion of the Operational Readiness and Functional Acceptance Tests for each major process system, the PCSI shall be responsible for operation of that major process system for a period of 30 consecutive days, under conditions of the 30-day Acceptance Test specified under Section 01756 and Section 13410, without a single non-field repairable malfunction. Network performance monitoring shall continue throughout the 30-day test period.

b. During this test, operations and PCSI personnel shall be present as required. The PCSI is expected to provide personnel for this test who have an intimate knowledge of the hardware and software of the system. Coordinate PCSI staffing requirements during the 30-day test to coincide with normal shift operations as much as possible. Off-shift emergencies shall be fully supported by PCSI staff. Provide PCSI staff with cell phones and pagers to ensure that support staff are available by phone and/or on-site within 4 hours of a request by operations staff.

c. While this test is proceeding, Engineer shall have full use of the system. Only plant operating personnel shall be allowed to operate equipment associated with live plant processes. Plant operations shall remain the responsibility of the City and the decision of operators regarding plant operations shall be final. Only City operating personnel shall be allowed to operate equipment associated with live plant processes.

d. Any malfunction during the tests shall be analyzed and corrections made by the PCSI. Engineer will determine whether any such malfunctions are critical and warrant a repeat of this test. Network performance excursions that exceed the maximum levels for errors developed by the PCSI and specified in these Specifications shall constitute a system malfunction.

e. Any malfunction during this 30 consecutive day test period, which cannot be corrected within 24 hours of occurrence by the PCSI's personnel, or more than two similar failures of any duration, will be considered as a non-field-repairable malfunction.

f. Upon completion of repairs, by the PCSI, the test shall be repeated as specified in these Specifications.

g. In the event of rejection of any part or function, the PCSI shall perform repairs or replacement within 10 Days.

h. All computer equipment, network equipment, controllers, data base, process controller logic, and graphical interface system errors must be functioning as required per the Specifications prior to the start of each test period. The 30 day test will not be considered successful until all data base points and logic functions are tested and verified to be correct.

i. The total availability of the system shall be greater than 99.5 percent during this test period. Availability shall be defined as:

AVAILABILITY = (TOTAL TIME – DOWN TIME) / TOTAL TIME

j. Down times due to power outages or other factors outside the normal protection devices or backup power supplies provided shall not contribute to the availability test times above.

k. Perform a final 30-day acceptance test of the entire plant-wide system following successful testing, startup, and operation of each interim phase.

END OF SECTION

SECTION 13550 – AERATION CONTROL SYSTEM

PART 1 GENERAL

1.1 THE REQUIREMENT

A. The AERATION CONTROL SYSTEM shall be designed and furnished by the BLOWER SYSTEM SUPPLIER as specified in Section 11502 – Geared Single Stage Centrifugal Blower Packages. Therefore, the AERATION CONTROL SYSTEM SUPPLIER and the BLOWER SYSTEM SUPPLIER are the same and may be cross referenced as such.

B. The AERATION CONTROL SYSTEM SUPPLIER and CONTRACTOR shall furnish and install valves, instrumentation, a Master Control Panel, and associated interfaces and programming to obtain a complete and automated Aeration Control System installation in the Oxidation Ditches and Aeration Basins trains as shown and specified herein and in accordance with the requirements of the Contract Documents. The Aeration Control System includes but is not limited to:

1. Sixteen (16) actuated air flow control valves.

2. Sixteen (16) air flow meters.

3. Sixteen (16) DO probes.

4. One (1) master control panel (MCP).

5. Custom designed software, associated interfaces, and programming to obtain a complete and automated aeration control system.

C. The system shown on the Drawings is based on the supply of the first-named Supplier, Manufacturer, or Vendor. The Drawings show a general depiction of the equipment and indicate a level of accessibility and clearances that shall be required for installation and maintenance of the system components. The specific location of system connections and equipment may vary depending on the System Supplier. Additionally, the quantity and methods used for meeting the Contract requirements for safety may differ between what is provided by the System Suppliers and what is shown on the Contract Drawings. The supplied system shall fit within the footprints shown on the Drawings while maintaining the level of accessibility and clearances shown on the Drawings. If the Contractor selects a System Suppler other than the first-named System Supplier, Contractor shall be responsible for the cost of all modifications required to provide the accessibility and clearance requirements, and modifications required of equipment that are tailored to the specific system design at no additional cost to the Owner. Such changes to the layout shall not impair the equipment accessibility or limit maintenance access as generally indicated on the Drawings, nor shall it relieve the System Supplier's responsibility for meeting the requirements of the Contract Documents. Any re-design of structures, foundations, support utilities, or any other related infrastructure needed to accommodate other than the first-named Supplier shall be borne by the Contractor, without additional cost to the Owner; any such re-design of related infrastructure shall be by the Owner's design engineer. Any costs associated with the Owner's design engineer evaluation of Contractor proposed alternate System Suppliers shall be borne by the Contractor.

D. All equipment specified in this section shall be designed and furnished by the AERATION CONTROL SYSTEM SUPPLIER / BLOWER SYSTEM SUPPLIER, who shall

be responsible for the suitability and compatibility of all included equipment as required for a complete and automated aeration system.

E. All equipment specified in this section shall be installed by the CONTRACTOR.

F. All equipment, valves, actuators, instrumentation and controls systems of the same type shall be by a single manufacturer. Selected equipment, valves, actuators, instrumentation and controls systems manufacturers on the project shall be identified in the construction bid form “Schedule of Major Equipment and Material Suppliers, Products Identified by Name and Substitution”.

1.1 REFERENCE SPECIFICATIONS, CODES, AND STANDARDS

A. Reference Specifications

1. Section 01340 - Shop Drawings, Product Data and Samples.
2. Section 01660 - Testing and Training
3. Section 01730 - Operation and Maintenance Data
4. Section 09900 - Paintings and Coating
5. Section 11450 – Fine Bubble Panel Diffuser Aeration System
6. Section 11500 - Blowers, Compressors, Vacuum Pumps General
7. Section 13400 – Common Work Results Process Instrumentation and Controls
8. Section 13421 – Programmable Logic Controllers and Computer Control Systems
9. Section 13422 – Local Area Network Systems
10. Section 13431 – Instrumentation and Controls – Analytical Devices
11. Section 13432 – Instrumentation and Controls – Flow Measurement
12. Section 13434 – Instrumentation and Controls – Pressure Measurement
13. Section 13482 – Process Control Descriptions
14. Section 13446 – Electrical Operators for Valves and Gates
15. Section 15200 – Valves General
16. Section 15201 – Valve and Gate Actuators
17. Section 15214 – Pressure Control Valves
18. Section 15203 – Check Valves
19. Section 15230 – Miscellaneous Valves
20. Section 15214 – Pressure Control Valves

21. Division 16 – Electrical

22. Section 16220 – Low Voltage Motors

23. Section 16442 – Motor Control Center

1.2 CONTRACTOR SUBMITTALS

A. General: AERATION CONTROL SYSTEM SUPPLIER and CONTRACTOR shall submit administrative, shop drawings, samples, quality control, and contract closeout submittals of all equipment furnished this Section and in referenced Sections in accordance with the requirements of Section 01340 Shop Drawings, Product Data and Samples.

B. Shop Drawings and Samples: In addition to the requirements of Section 01340 Shop Drawings, Product Data and Samples, AERATION CONTROL SYSTEM SUPPLIER and CONTRACTOR shall submit the following:

1. Provide the following submittals as described in Section 11000:

a. Product submittals
b. Schematic diagrams
c. Connection diagrams
d. Loop diagrams
e. Field wiring interconnection diagram

2. Provide electrical and motor control submittals as called for in Division 16.

3. A detailed aeration system performance test plan with complete piping and instrumentation configuration diagram. As a minimum, the detailed test plan shall include performance testing of entire blower system package and aeration system package, including, blowers, instrumentation, ancillary components, valves, DO probes, thermal mass flow meters, blower Local Control Panels (LCPs), the Master Control Panel (MCP), and all other equipment, instrumentation, and controls specified herein and in Specifications 11502 and 11000.

4. Unloading, handling, storage, and maintenance requirements

5. Instrument ranges and settings

6. Troubleshooting guide

7. List of components and catalog cuts fully describing all items:

a. Instruments
b. PLC
c. Master Control Panel and its components
d. Electrical components

C. Submittals

1. Submit complete information on the PLC, display system, and controls as required and as called for elsewhere in this Section.

2. Submit variable list showing the name and description of each register and/or bit in the register, as applicable. Highlight where SCADA interface points are located.

3. Submit narrative control strategies explaining package system functional control. Submit system block diagrams showing all digital and hardwired interfaces. Submit an input/output list, as well as a description of the interface with the SCADA system. Submit flow charts, block diagrams, and other descriptive material as needed to fully describe system overall function.

4. Submit PLC application program in both hardcopy and electronically early in the project, prior to startup again, (following factory testing and resulting fixes), and then as finally installed and tested.

5. Submit screens both in color hardcopy and electronically on the same schedule as PLC application program above.

6. SCADA Interface Testing: Submit a test plan with testing forms describing in detail how the interface between the package and the SCADA system will be demonstrated. Testing shall include a test for each interface point and demonstration of each function.

7. Integrate all submittals in final O&M's. Update and coordinate documents to provide a complete and cohesive PLC/screen documentation package.

D. O & M Manuals: The AERATION CONTROL SYSTEM SUPPLIER and CONTRACTOR shall provide operations and maintenance data for all equipment furnished for the project in accordance with Section 01730 - Operation and Maintenance Data.

E. Tools: Special tools necessary for maintenance and repair of the equipment shall be furnished as a part of the WORK hereunder; such tools shall be suitably stored in metal tool boxes, and identified with the equipment number by means of stainless steel or solid plastic name tags attached to the box.

1.3 QUALITY ASSURANCE:

A. AERATION CONTROL SYSTEM SUPPLIER and CONTRACTOR shall submit the following:

1. Supplier's Certificate of Proper Installation

2. Functional Test Certification

3. Factory performance test reports

4. Special shipping, storage and protection, and handling instructions

5. Manufacturer's printed installation instructions

6. List of suggested spare parts to maintain the equipment in service for a period of 5 years. Include a list of special tools required for checking, testing, parts replacement, and maintenance.

7. List of special tools, materials, and supplies furnished with equipment for use prior to and during startup.

B. Warranty

1. A written Suppliers Warranty shall be provided for the equipment specified in this section as required in Section 01740 - Warranties and Bonds.

2. The equipment shall be guaranteed to meet or exceed the design criteria specified.

1.4 SUPPLIER'S SERVICE REPRESENTATIVE

A. In accordance with the requirements of Section 01660 - Testing and Training, a AERATION CONTROL SYSTEM SUPPLIER'S Representative shall be present at the site or classroom designated by the OWNER to provide the services and minimum person-days listed below, travel time excluded.

1. One (1), eight-hour (8-hr.) days for each aeration train for installation assistance and final installation inspection

2. Three (3), eight-hour (8-hr.) days for the MCP.

3. Three (3), eight-hour (8-hr.) days for each aeration train for functional testing, performance testing, adjustment and optimization of the aeration system valves and controls.

4. Two (2), eight-hour (8-hr.) days for a factory representative, who has complete knowledge of proper operation and maintenance shall be provided to instruct representatives of the OWNER and ENGINEER on proper operation and maintenance, including pre-startup, start-up and shut-down procedures, proper lubrication practices, and troubleshooting of all equipment.

5. If there are difficulties in operation of the equipment due to the Manufacturer's fabrication or Contractor's installation, additional service shall be provided at no extra cost to the Owner.

PART 2 PRODUCTS

2.1 GENERAL

A. Three duty blowers with one standby blower will be used for supplying variable volumes of air to the Oxidation Ditch and Aeration Basin zones as specified in Specification 11502. The Aeration Control System shall be a complete and automated system to control the airflow to the aeration zone. All items specified in this Section shall be supplied by the AERATION CONTROL SYSTEM SUPPLIER / BLOWER SYSTEM SUPPLIER to provide a properly functioning aeration system with the objective to minimize power consumption while providing the proper volume of air to each Oxidation Ditch or Aeration Basin zone.

B. All components shall be new. Both workmanship and materials shall be of the very best quality and conform to all applicable sections of these Specifications. It shall be understood that components specified establish minimum requirements only, and do not relieve the AERATION CONTROL SYSTEM SUPPLIER or CONTRACTOR of responsibility for providing a properly functioning system.

C. Components to be provided by the AERATION CONTROL SYSTEM SUPPLIER include the following:

1. Sixteen (16) actuated air flow control valves.

2. Sixteen (16) air flow meters.

3. Sixteen (16) DO probes.

4. One (1) master control panel (MCP), which shall control operation and sequencing of the overall blower and aeration systems.

5. Custom designed software, associated interfaces, and programming to obtain a complete and automated aeration control system.

6. Startup, testing, and training services

7. Spare parts

2.2 PERFORMANCE REQUIREMENTS

A. Design Criteria: The aeration control system shall conform to the following conditions:

Maximum air flow rate (scfm), total	13,950
Minimum air flow rate	2,140
Design discharge pressure (psig), max	7.8
Design discharge temperature (degrees F), max	205

2.3 AIR FLOW CONTROL VALVES

A. Valve and accessory components shall be provided by the Manufacturer in accordance with:

1. Section 15000 – Piping General

2. Section 13446 – Electrical Operators for Valves and Gates

3. Section 15200 – Valves General

4. Section 15201 – Valve and Gate Actuators

5. Section 15214 – Pressure Control Valves

6. Section 15203 – Check Valves

7. Section 15230 – Miscellaneous Valves

8. Section 15214 – Pressure Control Valves

B. Air flow valves and instrumentation shall be furnished by the AERATION CONTROL SYSTEM SUPPLIER, who shall be responsible for the entire system performance and compatibility.

C. The AERATION CONTROL SYSTEM SUPPLIER and CONTRACTOR shall provide a total of four (4) actuated high performance butterfly valve assemblies per aeration train (16 total) for low pressure air service control in the aerated zones within the Oxidation Ditches and Aeration Basins. The actuated butterfly valve assemblies shall be designed and constructed in accordance with the requirements in this section.

D. The modulating valves shall be sized by the AERATION CONTROL SYSTEM SUPPLIER, using air flow rates to aerated zones as described in Specification 11450, Fine Bubble Panel Diffused Aeration System, for near linear control over the operating range.

E. Air flow rates for each zone shall be confirmed by the Fine Bubble Diffused Aeration System Supplier and coordinated with the AERATION CONTROL SYSTEM SUPPLIER. The air flow range in various size air header droplegs at the air control and measurements points below are provided for preliminary design and sizing only.

1. 10” = 480 – 2,100 scfm

2. 8” = 270 – 1,050 scfm

3. 6” = 100 – 600 scfm

4. 4” = 130 – 250 scfm

F. The CONTRACTOR shall provide long taper concentric pipe reducers on each side of the valve, if required.

G. The CONTRACTOR shall install each valve as illustrated in the drawings and wire to the MCP.

H. If AERATION CONTROL SYSTEM SUPPLIER recommends, based on their design of the system, a different size valve than what is shown on the plans, and the recommendation is approved by the ENGINEER, the CONTRACTOR shall provide the recommended size valve. If the recommended valve is a larger size than what is shown on the drawings, it shall be provided at no additional cost to the OWNER. A smaller recommended valve shall be provided with a cost credit to the OWNER.

I. Actuators

1. Unless noted otherwise, valve actuators shall conform with Section 13446.

2. The valve operator shall be motorized, 460/60/3, NEMA 4X, modulating, equipped with open/close limit switches and continuous position feedback, and shall be suitable for air service up to 400 degrees F.

3. The hydraulic actuator shall clearly indicate valve position locally. At a minimum the valve actuators shall include electric controls, open/closed position limit switches, and declutchable manual overrides.

4. The valve actuators shall be capable of operation in response to a local manual “OPEN” or “CLOSE” pushbuttons at the actuator or automatically through the

SCADA control system. A continuous position feedback system shall be provided between the valve actuator and the SCADA system. In addition, the “air” valve actuators shall be equipped with end-of-travel electric limit switches to indicate both “Full Open” and “Full Closed” positions. Modulating valve actuators shall include the ability to transmit a 4-20 mA continuous position indication signal for remote monitoring by the SCADA system.

5. Upon loss of primary power the valves shall maintain their current position.

6. The actuators shall be specifically designed for 100 percent continuous duty modulating control. The actuator shall provide sufficient force throughout entire valve stroke to overcome valve breakaway/seating friction and process dynamics. The speed of the actuator shall be electronically adjustable at the actuator primary control panel. The dead band sensitivity shall be selectable at the primary control panel between and provide a minimum of 0.1% to 5% of the calibrated signal span values.

7. Signal repeatability shall be a minimum of 0.10% of full travel. Response shall be virtually instantaneous with zero overshoot of target position.

8. Controls for the valves shall be located in the MCP with display on the Operator Interface.

9. Manufacturers:

   a. Rotork

   b. AUMA

   c. Or Approved Equal

J. Actuated Butterfly Valve Design Requirements

1. Location: Outdoors, Low Pressure Air Service Piping as Shown on the Drawings

2. Type of Unit(s): Self-Contained, Rotary or Quarter Turn Hydraulic Actuator

3. Number of Unit(s): Sixteen (16)

4. Power Source: 460 Volt, 3 Phase, 60 Hertz

5. Electrical Classification: Unclassified, Electrical Hazard Environment

6. Electrical Enclosure: NEMA 4X, Stainless Steel, For Outdoor Service

7. Valve Type: New, sized varies, “High Performance” Butterfly Valves

8. Operating Time: 60 Seconds – Fully Open to Fully Closed

9. Stroke Rate: 28.6 Seconds Per 900 Rotation

10. Rated Torque Output: 5,000 inch-lbs

11. Manual Override: Declutchable Hand Wheel with Drill Drive

12. Open & Closed Limit Switches: Required – Electric Type

13. Position Feedback: Continuous position

K. High Performance Metallic Air Service Butterfly Valves

1. Unless otherwise noted the air flow control valves shall meet the requirements of Specification 15200, Valves General.

2. All high performance butterfly valves for low pressure air service shall be manufactured in accordance with ANSI B 16.34 standards. The valve disc edge shall be machined to a smooth surface. The valves shall be provided with shaft seals to protect the valve bearings from corrosion and well as prevent air leakage. To minimize bearing and shaft seal wear, the valve shafts shall be one-piece, ground and polished to finish grade. The valve disc edge shall be machined to a smooth surface. The valves shall be provided with shaft seals to protect the valve bearings from corrosion and well as prevent air leakage. To minimize bearing and shaft seal wear, the valve shafts shall be ground and polished to finish grade. The seat retaining ring shall be nested in the valve body, providing support and protection for the seat and a captured blow-out resistant body-to-retainer seal.

3. The valves shall be lugged body type. Lugs shall be cast solid and faced accurately at right angles to the axis of the casting. All lugs shall be faced drilled and provided with a shop coating to prevent rust prior to shipment. Stainless steel lug bodies shall not be painted. The valve shall be designed to fit between two ANSI B16.1, 150-pound steel or cast iron flanges

4. The valve shall be designed with a single offset disc design to provide an uninterrupted 360° sealing surface. The valve, seat, and appurtenances shall be specifically designed for use in “High Cycle” modulating low pressure air control service with a control valve actuator. The valve shall be rated for a minimum pressure of 150 psi at ambient temperature. The valves shall also be designed and constructed in accordance with the following criteria:

   a. Size: Varies, Match to Piping Size as Shown on Drawings

   b. End Connections: Lugged - ANSI 150, B16.104

   c. Valve Body: Cast 316 Stainless Steel, per ASTM A 351, Type CF8M

   d. Packing: PTFE, Rated for 500 ^{0}F Temperatures

   e. Disc: 316 Stainless Steel

   f. Shaft: 316 Stainless Steel

   g. Bearings: Fabric PTFE / 317 Stainless Steel to 500 ^{0}F

   h. Seat: Reinforced PTFE with Inconel & Stainless Steel to 500 ^{0}F

   i. Hardware (Bolts, Nuts, Washers, Springs, Etc.): 316 Stainless Steel

   j. Valve Torque Requirements: 275 foot-lbs (Maximum)

k. The valves shall be specifically designed for modulating air service with a control valve actuator. The valve shall exhibit the flow characteristics based on percentage of valve open and the corresponding percent of maximum flow as shown in the table below. The valve Manufacturer shall provide a curve which shall meet or exceed the following minimum flow performance standards. Submit a performance curve for review and approval by the Engineer.

Valve Percent Open	Percent of Maximum Flow
0%	0%
10%	5%
20%	10%
30%	15%
40%	25%
50%	35%
60%	48%
70%	63%
80%	78%
90%	95%
100%	100%

5. Specific Submittal Requirements:

a. Submittal information shall include a detailed analysis of sizing with valve flow linearity versus flow.

6. Manufacturers:

a. DeZURIK – Sartell Valves Inc. – Series BHP

b. Neles Jamesbury Company – Series 815

c. Or Approved Equal

2.4 AIR FLOW METERS:

A. Unless otherwise noted, instrumentation components shall be provided by the Manufacturer in accordance with:

1. Section 13400, Common Work Results Process Instrumentation and Controls

2. Section 13432, Instrumentation and Controls – Flow Measurement

B. Provide four (4) thermal mass air flow meter, transmitters, and appurtenances per aeration train (16 total) as shown on the drawings.

C. Control wiring and signals shall report to and from the MCP.

D. Air flow meter shall be suitable for the operating parameters listed below;

1. Flow range of 150 to 3,000 scfm

2. Pressure range of 7 to 10 psi

3. Maximum temperature of 250 degrees F

2.5 DISSOLVED OXYGEN PROBES:

A. Unless otherwise noted, instrumentation components shall be provided by the Manufacturer in accordance with:

1. Section 13400, Common Work Results Process Instrumentation and Controls

2. Section 13431, Instrumentation and Controls – Analytical Devices

B. Provide four (4) dissolved oxygen (DO) probes and analyzers per aeration train (16 total), including all handrail mounted immersion hardware.

C. Power and control signals for the DO analyzers shall report to and from the MCP.

2.6 MAIN HEADER PRESSURE TRANSMITTER:

A. Instrumentation components shall be provided by the Manufacturer in accordance with:

1. Section 13400, Common Work Results Process Instrumentation and Controls

2. Section 13434, Instrumentation and Controls – Pressure Measurement

B. Provide one (1) main air header pressure transmitter located in the main air header, as shown on the drawings.

C. Transmitter shall be installed with a valve isolated fitting such that the air header can remain in use if the transmitter has been removed.

D. Power and 4-20 mA signals for the pressure transmitter shall report to and from the MCP.

2.7 CONTROL PANELS

A. General

1. Provide a master control panel (MCP) for the Aeration Control System / Blower Package System. Control panels and components shall meet all applicable requirements of Section 11000 including, but not limited to, requirements for submittals, components, materials, workmanship, and testing.

2. Components include auxiliary motor starters, circuit breakers, control components, power supplies, and pilot devices.

3. The MCP shall be type 316 stainless steel, NEMA 4. Mounting shall be as shown on the Drawings.

4. Provide a panel space heater and cooling system(s), as required, in each control panel. Perform heat rise calculations and provide cooling systems if required to maintain internal panel temperature to within equipment tolerances. Refer to Section 13400 and 11000 for detailed requirements on temperature control in control panels.

5. The MCP shall include a main electrical panel disconnect meeting the requirements of Section 11000, Division 16, and the National Electrical Code.

6. The MCP shall include a programmable logic controller (PLC) per Section 11000.

7. The MCP shall include a panel-mounted graphical local operator interface terminal (OIT) as described elsewhere in this Specification.

8. The MCP shall accept serving voltage as noted. Provide control power transformer(s) as required and as specified in 11000.

B. Master Control Panel (MCP)

1. The MCP shall provide air header pressure control over a range of 7 to 7.8G psig with any or all of the blowers in service. The PLC shall receive the main air header pressure 4-20 mA signal. The main air header pressure variable input is compared with an air header set point, with the MCP directing increase or decrease of on-line blower volume to maintain the pre-set air header pressure. The discharge pressure set point shall be adjustable from the MCP or from a remote serial or analog input provided by others.

2. The MCP shall provide overall aeration and blower control, and shall meet general control panel requirements specified earlier.

3. The MCP shall interface with, and monitor (and control as applicable), the devices listed herein via hardwired connections.

4. The MCP shall interface with the four blower LCPs, receive comprehensive blower statuses and alarms, and command each blower based on aeration control logic within the MCP.

5. The MCP shall be networked with each LCP specified in Sections 11502 – Geared Single Stage Centrifugal Blower Packages and with the Plant SCADA network via Ethernet as shown on the Drawing and as specified herein. Under normal operating conditions, the plant control network shall be the principal interface with the remainder of the plant. Provide the following redundant hardwired interfaces with the plant control system:

<u>Analog Inputs To MCP</u>

All 4-20 mA signals from the header pressure instrument, air flow control valves, air flowmeters, and DO probes.

- LCP to MCP with be through Ethernet.

<u>Analog Outputs From MCP to Plant SCADA</u>

All Analog inputs to MCP from the Aeration Control System
All Analog inputs from LCPs to MCP from the Blower Systems
Allow adjustment of all setpoints

<u>Discrete Inputs To MCP</u>

Per the blower system specification Section 11502,

Discrete Outputs From MCP to Plant SCADA

Blower ON (four signals)
Blower OFF (four signals)
Blower TROUBLE (four signals)
Auto Sequence Enabled
Provide controls and interposing relays to support control of up to eight devices

Provide NETWORK/HARDWIRED selection. When selected HARDWIRED, the package shall use the hardwired inputs for operation and ignore the networked inputs. This mode of control will be used during startup and in the event of failure of the plant control network or local PLC.

6. Plant SCADA Pre-Start and Operational permissives will determine if the MCP can initiate start of the blowers and aeration control system. Permissives will be ON/OFF selections by the Plant Operators:

a. "Oxidation Ditch #1 Aeration System ON" – for OD #1
b. "Oxidation Ditch #2 Aeration System ON" – for OD #2
c. "Aeration Basin #3 Aeration System ON" – For AB #3
d. "Aeration Basin #4 Aeration System ON" – For AB #4

7. Provide a graphical Local Operator Interface Terminal (OIT) that incorporates controls, alarms, and displays in easy-to-interpret graphical screens.

a. Provide a comprehensive operator interface, including all controls, indications, displays, alarms, and features required to operate and maintain the system. Include the functions below on OIT graphics prepared for this Project. At a minimum:

a. Blower statuses/alarms.
b. Valve statuses/alarms.
c. Other statuses/alarms.
d. Process conditions.
e. Operating mode.
f. Alarm system (in conformance with plant standards).
g. Password controlled access to setpoints.
h. Selection of blower call sequence, automatic alternation provisions based on operating cycle or routine.
i. Control mode selection, other operator inputs, statuses, and monitoring and control to effect the automatic operations below.

b. Provide a minimum of 20 graphical screens for monitoring and control features. Graphics shall match the existing look and feel of the existing Brentwood WWTP SCADA system as specified under Section 13400.

c. The programmable electronic OIT shall have multiple color screens to display operating variables, valve positions, and other relevant data. Operating screens shall have a touch sensitive screen point to select the start sequence of the blowers, a touch sensitive screen point for pressure set point adjustment and the local/remote touch sensitive screen point for local or remote pressure or most open valve system control. The operation shall be programmed to be user friendly by providing sufficient prompting

that an operator can intuitively follow through the commands to operate the blower system.

a. Displays and controls shall be provided to monitor all process variable input for master control and to monitor and modify set points, as required.

b. The monitor shall display screens identifying the blowers on-line including the lead blower and the ability to modify the lead blower selection.

c. The monitor shall provide options for control of the blowers and air flow control valves as a manual function, air header pressure controlled via manual set point, or via floating air header pressure set points based on most open valve philosophy. All valve positions shall be displayed with the most open valve being appropriately identified.

8. Provide front-of-panel hardwired devices in addition to the graphical displays as needed for system control, monitoring, and protection, with the following minimum:

   a. Control power ON/OFF selection.
   b. Control power ON indication.

C. AERATION SYSTEM CONTROL MODES

There are multiple aeration system control and corresponding blower system control modes selectable by the Operator. These modes are controlled through the MCP.

1. Pressure Control

The MCP shall provide two modes of air header pressure control:

a. Fixed Mode: in which the pressure setpoint is adjusted at the LOI, or from within the plant SCADA system. Through the use of a PID algorithm the MCP PLC shall make decisions to maintain a constant pressure in the common discharge header. This pressure shall be maintained by monitoring the air pressure in the main discharge header. The MCP then varies the air flow of the blowers via the percent command to meet the pressure set point as set on the HMI or VIA the SCADA control link. The MCP shall start/stop and increase/decrease the blower(s) accordingly to maintain at setpoint. Tuning parameters shall be password protected.

b. Most Open Valve Control: in which the pressure controller setpoint is calculated based on the air flow control valve most open position. In addition to the air header pressure 4-20 mA signal input, the MCP shall also receive 4-20 mA position signal input from each air flow control valve. Refer to Most Open Valve Control below.

c. For all pressure control modes the pressure setpoint versus valve position function shall be a linear function derived from field operated experiments, which shall be designed and conducted by the AERATION CONTROL SYSTEM SUPPLIER to determine the most efficient header pressure throughout the range of valve positions. All parameters that are used in the algorithm to calculate the pressure setpoint shall be password protected.

d. The transfer between Fixed Mode and Most Open Valve mode shall be bumpless.

2. Air Flow Control

The MCP shall provide two modes of air flow control:

a. Air Flow Control: in which the MCP shall control air flow control valve accordingly to maintain a setpoint based on the Operator entered air flow setpoint (at LOI or from SCADA). Tuning parameters shall be password protected.

b. Cascade Control: the setpoint is adjusted based on the DO controller (AIC) output to maintain at DO setpoint based on the Operator entered DO setpoint. Tuning parameters shall be password protected.

c. The transfer between Air Flow Control and Cascade Control shall be bumpless.

d. The blower and aeration system control shall use inputs of DO, air flow, valve position, and main air header pressure to optimize system design, the objective being to operate at the lowest system pressure and DO to affect modulation of air flow to all cells.

e. The MCP shall have process integrating control loops for each air flow meter, and air flow control valve. Each sensor shall be maintained at a pre-set level from the MCP via a manual setpoint at the MCP. The air flow meter shall be used as the control function and air flow control valve as the controlled function. The sensor probes shall input to the MCP providing a secondary control loop to optimize the air flow rate with DO control. Maximum and minimum air flow Setpoints and warning alarms shall be based on design parameters set during the submittal stages by the ENGINEERS.

f. The MCP PLC shall have all blowers and PLC monitor and statuses (indication, alarm, shutdown, etc.) with internal coils and registers for the plant SCADA to read data. The AERATION CONTROL SYSTEM SUPPLIER shall be responsible for integrating the data into the plant SCADA system.

3. Most Open Valve Control

a. The MCP PLC shall utilize a “Most Open Valve” approach to control the splitting of air to the desired oxic zones. Each oxic zone is equipped with at minimum an air flow meter and a modulating control valve for throttling the air to the specific zone. Each oxic zone can be selected to operate in one of two methods depending upon the installation.

b. For Air Flow Control the operator can enter a setpoint for the desired air flow into each provided oxic zone. Based upon this air flow setpoint the modulating valve for the zone is controlled using a PID based algorithm to open or close to provide the desired amount of air flow to the system. The

loop is tuned so the valve will operate very slowly over time as to not surge the blowers or burn out the valve actuators. If the air flow to the zone is too small the valve will open, and the valve will close if the air flow is too high to the zone.

c. For DO control at least one DO probe is required per zone. The operator shall enter a desired DO set point for each zone. Based on the DO set point for the zone a PID algorithm is used to calculate the required flow set point. The DO PID algorithm shall be “reverse acting”, that is, as the actual DO exceeds the set point, the flow set point will decrease. Since the DO PID output is the Flow control PID set point, when there is an excess of DO, the flow PID set point shall decrease, requiring less air flow and closing the modulating valve. See the air flow control description above.

d. The MCP will monitor the valve positions of each modulating valve to each zone. If one of the valves is not 100% open then at a pre-determined interval the MCP will increment the command to each control valve by an operator adjustable amount. This will ensure that at minimum at least one valve is fully (or nearly fully) open at all times and the header air pressure is minimized in the system.

e. The “Most Open Valve” is the most desired style, and if fact should be used at all times assuming the system is operating normally for an aeration system. This mode will provide the desired DO to each zone, which is of the final objective, and will maximize the power savings by decreasing the discharge header pressures. The “Air Flow Control” mode should be used when DO control cannot be used.

4. Blower Staging Control: The PLC shall bring blowers on and off-line and increase/decrease on-line blower capacity based on cascade control logic. The result being a gradual increase/decrease of air throughout the entire range of one (1) to three (3) duty blowers on-line. System shall be capable of adding the fourth (standby) blower into the control strategy as future plant demand requires. In the event of a blower failure, the next blower in the pre-selected start sequence shall come on-line.

2.8 DEVICE INTERCONNECTION

A. These specifications may call for interconnected skid-mounted systems including driven equipment, instrumentation, and control panels. Interconnection consists of power, discrete, networking, and analog signal conduit and wire. The AERATION CONTROL SYSTEM SUPPLIER / BLOWER SYSTEM SUPPLIER shall prewire all system components, except for those items explicitly called out otherwise in these Specifications and shown on the electrical drawings or P&IDs.

B. Prior to fabrication, provide complete and detailed interconnection diagrams of skid-mounted items, which also shows all external connections related to the blower system. Identify which interconnection is factory-completed, which is supplier-finished in the field, and which is by an entity other than the AERATION CONTROL SYSTEM SUPPLIER / BLOWER SYSTEM SUPPLIER. The CONTRACTOR’s organization shall coordinate among itself during bid and during construction to ensure that all required interconnection is planned, furnished and installed, and documented.

2.9 PLC SYSTEM COORDINATION

A. Provide a complete and operable PLC control system meeting the requirements of Section 11000.

B. Programming Requirements

1. Code shall be fully annotated to the best practices of the industry. Early submittals of programming and screens shall demonstrate the AERATION CONTROL SYSTEM SUPPLIER's proposed approaches, and the OWNER's representatives will mark up submittals with general requirements, which then shall be incorporated by the AERATION CONTROL SYSTEM SUPPLIER throughout and resubmitted if necessary.

2. The display system shall be a panel-mounted graphical local OIT interfaced to the system PLC specified in Section 11000.

3. PLC logic development, variable tagging, program structure, and screen conventions shall match the look and feel of colors, layout, depictions, structure, etc., as needed to conform to the existing plant standards. Refer to Section 13400.

C. Network Requirements

1. The LCP PLC's shall communicate with the MCP PLC via a dedicated blower control network, using Ethernet, Modbus TCP protocols. The MCP PLC shall be connected to the Plant control network and shall interface with the supervisory SCADA network. Both the control and supervisory networks shall be based on Ethernet Modbus TCP protocol as shown on the Drawings and per 13422.

2. The AERATION CONTROL SYSTEM SUPPLIER shall take an active role in defining, implementing, and starting up system communications between MCP and LCPs. The AERATION CONTROL SYSTEM SUPPLIER shall provide onsite technical assistance with personnel qualified to make and document field adjustments in support of communications start-up for communications from MCP to plant SCADA components.

3. Provide a compact block of 100 registers from which the plant PLC's and SCADA servers interfacing with the MCP PLC can read process variables. Similarly, reserve a compact block of up to 50 registers to which the SCADA servers interfacing with the MCP PLC can write process setpoints. Refer to Section 13482 for SCADA communication requirements.

2.10 OTHER REQUIREMENTS

A. Provide interconnection schematic diagrams. The AERATION CONTROL SYSTEM SUPPLIER of the systems specified in this Section shall provide information and prepare documentation as required in the development and submission of interconnection diagrams.

B. Documentation

1. For control equipment, provide complete documentation (submittals, panel drawings, test procedures and test reports, programming documentation, and O&M manuals) as specified in Section 11000.

2. Shop drawings shall be submitted for review in accordance with Section 11000.

3. Provide shop drawings for instrumentation and controls, electrical items, and electric motors, in accordance with Section 11000 and 16220.

2.11 CONTROL PANEL DESIGN AND TESTING

A. The LCP and MCP design, construction, and testing shall be completed by the BLOWER MANUFACTURER conforming to the requirements of Section 11000 including control panel provided in conformance with UL 508A and UL 508C.

B. Testing shall be in an ISO 9001 certified shop. This testing in the Blower MANUFACTURER's shop shall be completed as specified in this Specification section.

PART 3 EXECUTION

3.1 DELIVERY AND STORAGE

A. A complete set of AERATION CONTROL SYSTEM SUPPLIER's instructions covering storage, installation, operation, lubrication, and maintenance shall be furnished to the OWNER no later than the date the equipment is shipped. Care during storage and procedures for installation, lubrication, and startup of the equipment and motors shall be in strict conformance with the AERATION CONTROL SYSTEM SUPPLIER's instructions.

3.2 INSTALLATION

A. Install in accordance with the AERATION CONTROL SYSTEM SUPPLIER's printed instructions.

B. Coordinate installation and startup scheduling and activities with those for the rest of the project, particularly for plant control system activities.

3.3 WORKSHOPS

A. The AERATION CONTROL SYSTEM SUPPLIER and the CONTRACTOR shall conduct two, 6-hour meetings during the programming planning and development process to coordinate detailed requirements for logic development, PLC program structure, graphical development, network data exchange, installation commissioning, testing and startup. These meetings shall not be a substitute for complete and responsive submittals related to the control system work.

B. The AERATION CONTROL SYSTEM SUPPLIER or CONTRACTOR shall prepare a detailed agenda for each workshop, and publish detailed minutes for each.

C. These workshops shall not relieve the AERATION CONTROL SYSTEM SUPPLIER or CONTRACTOR for other planning and submittal responsibilities associated with the Aeration Control System Package.

D. Workshops shall include agenda topics to assure conformance with the data exchange requirements as specified in Section 13482. In addition, Package System signals

interfacing with the Plant PLC system shall be identified and control system responses to those signals shall be defined by the AERATION CONTROL SYSTEM SUPPLIER.

3.4 TESTING

A. Factory Testing

1. Factory testing shall be in coordination with Specifications 11502. The MCP shall be connected to all blower local control panels. The entire system of all blowers, local panels, and the MCP shall be demonstrated to the witnessing ENGINEER as an operating system before shipment. All system I/O addressing and graphical monitoring and control interfaces shall be 100% tested. Perform testing of the network based data exchange to plant SCADA using a laptop, auxiliary PLC, or other means to confirm transmission and reception of all network resident variables. The ENGINEER shall be allowed to witness each step of each test, and no items shall be shipped from the factory prior to favorable performance of the entire system. The AERATION CONTROL SYSTEM SUPPLIER or CONTRACTOR's representative shall sign the test procedure and results, certifying that the assembled blowers and motors, auxiliaries, LCP, and MCP's were successfully tested together as a system.

2. Test procedures shall be comprehensive, step-by-step, in a cause-and-effect format.

3. Factory testing shall be also executed unwitnessed.

4. Provide the following formal submittals:

a. Test procedures, at least 6 weeks in advance of scheduled unwitnessed testing.

b. Unwitnessed test results, at least 3 weeks in advance of scheduled witnessed testing.

c. Witnessed test results, prior to shipping products to the field.

B. Performance Testing

1. The AERATION CONTROL SYSTEM SUPPLIER shall furnish an experienced service representative to inspect the final installation and supervise the field acceptance tests of the equipment. The services of the representative shall be as listed in this specification. If there are difficulties in operation of the equipment due to the AERATION CONTROL SYSTEM SUPPLIER's fabrication or CONTRACTOR's installation, additional service shall be provided at no extra cost to the OWNER until problems are resolved.

a. Conduct a minimum of 14 days field acceptance test of the aeration system instrumentation, controls, and valves. The test shall demonstrate the following:

1) Confirmation that startup testing as specified in Section 11000 has been completed successfully.

2) The air header pressure control loops will automatically control on-line blowers without hunting.

3) Air flow control valves to each aeration basin zone will increase/decrease air flow based on DO and the air flow required.

4) Air flow control loop will change air flow Setpoint based on DO input.

5) The entire aeration system of blowers, air flow control valves, and instrumentation operates in a stable fashion, without hunting, maintains air flow control valves in their most open position, and maintains DO at operator set levels in the aeration basin zones.

2. Field acceptance testing shall be conducted after the installation of all equipment has been completed and the equipment has operated for a sufficient period to make all desirable corrections and adjustments. The AERATION CONTROL SYSTEM SUPPLIER or CONTRACTOR shall schedule testing with the full knowledge and consent of the OWNER and shall ensure no adverse affect on the operation of plant facilities.

END OF SECTION

SECTION 14552 – SCREW CONVEYORS – MODIFICATIONS AND IMPROVEMENTS

PART 1 GENERAL

1.1 THE REQUIREMENT

A. This section covers the furnishing of screw conveyors as indicated herein:

Conveyor designation.	Dewatered Sludge Conveyor 3	Dewatered Sludge Conveyor 4
Number of conveyors.	One (1)	One (1)
Conveyor tag numbers.	14-ME-03-DWS	14-ME-04-DWS
Conveyor location.	Existing Solids Building	Existing Solids Building, New Outdoor Truck Bay, and Dryer Building

B. This section covers the modification of the following existing screw conveyors:

Conveyor designation.	Dewatered Sludge Conveyor 1 & 2
Number of conveyors.	Two (2)
Conveyor tag numbers.	14-ME-01-DWS
	14-ME-02-DWS
Conveyor location.	Existing Solids Building

C. General
1. Equipment furnished under this section shall be fabricated and assembled in full conformity with Drawings, Specifications, engineering data, instructions, and recommendations furnished by the equipment manufacturer unless exceptions are noted by Engineer.
2. The supplier shall review the contract Drawings and installation requirements and shall make any modifications required for proper installation subject to acceptance by the Engineer.
3. Power Supply: Unless otherwise indicated, power supply to the equipment shall be 480 volts, 60 Hz, 3 phase.
4. The Contractor shall coordinate the equipment specified herein with equipment specified elsewhere that will discharge into the conveyors or discharge out of the conveyors. This includes coordination of chute and flange connection dimensions. The Contractor shall be responsible for coordinating changes to the conveyors without additional cost to the Owner. Any changes identifies shall be subject to acceptance by the Engineer.
5. Equipment specified herein shall be identified in accordance with the Equipment and Valve Identification section.
6. Shop and field welding procedures, welders, and welding operators shall be qualified and certified in accordance with the applicable provisions of the Structural Welding Code, AWS D1.1, of the American Welding Society.

1.2 REFERENCE SPECIFICATIONS, CODES, AND STANDARDS

AISC - American Institute of Steel Construction

ANSI - American National Standards Institute

ASTM - American Society for Testing and Materials

ASME - American Society of Mechanical Engineers

AWS - American Welding Society

CEMA - Conveyor Equipment Manufacturers Association

IEEE - Institute of Electrical and Electronics Engineers

NEC - National Electric Code

NEMA - Standards of National Electric Manufacturers Association

NFPA - National Fire Protection Association

OSHA - Occupational Safety & Health Act

UL - Underwriters' Laboratories, Inc.

1.3 CONTRACTOR SUBMITTALS

A. General: CONTRACTOR shall submit administrative, shop drawings, samples, quality control, and contract closeout submittals of all equipment furnished this Section and in referenced Sections.

B. Shop Drawings and Samples: Shop drawings and samples shall be submitted in accordance with the requirements of Section 01340 Shop Drawings, Product Data and Samples.

C. O & M Manuals: The CONTRACTOR shall provide operators and maintenance data for all equipment furnished for the project in accordance with Section 01730, Operation and Maintenance Data.

D. Tools: Special tools necessary for maintenance and repair of the equipment shall be furnished as a part of the WORK hereunder; such tools shall be suitably stored in metal tool boxes, and identified with the equipment number by means of stainless steel or solid plastic name tags attached to the box.

E. Screw Conveyors and Accessories

1. Calculations for conveyor sizing, spiral strength (elongation), torque, and horsepower.
2. Specifications for materials of construction.
3. Detailed general arrangement drawings of conveyor system
4. Dimensions and weight of overall unit

5. Dimensions and weight of components (if shipped as components)
6. Locations of lift points and tie-down points
7. Details of all supports to be used by the unit when in place
8. Dead and live load details for all support locations
9. Rotating speed(s).
10. Detailed shop drawings of screw conveyors and trough body.

F. Slide Gates

1. Name of manufacturer and catalog data.
2. Detailed drawings and dimensions.
3. Specifications for materials of construction.
4. Actuator drawings and details.

G. Drive

1. Name of manufacturer.
2. Type and model.
3. Type of bearings and lubrication.
4. Input/output speed(s).
5. Net weight.
6. Service factor at installed horsepower.

H. Motors

1. As specified in the Low Voltage Motors section

I. Seismic Design Requirements

1. Confirmation of compliance with the requirements of the Seismic Design Criteria and Seismic Wind Criteria sections

1.4 QUALITY ASSURANCE

A. CONTRACTOR shall submit the following:

1. MANUFACTURER's Certificate of Proper Installation
2. Functional Test Certification
3. Factory performance test reports
4. Special shipping, storage and protection, and handling instructions
5. MANUFACTURER's printed installation instructions
6. List of suggested spare parts to maintain the equipment in service for a period of 5 years. Include a list of special tools required for checking, testing, parts replacement, and maintenance.

7. List of special tools, materials, and supplies furnished with equipment for use prior to and during startup.

8. Information to establish the qualifications of the conveyor manufacturer. The conveyor supplier shall have installed similar equipment conveying the specified materials at wastewater facilities for at least 5 years. The information shall include, but not be limited to, operating data and experience records from at least three similar operating installations that are currently in operation and have a minimum of 15,000 hours of operation. Names and telephone numbers of contacts at each installation shall also be provided. Failure to provide qualifications showing the specified experience shall be grounds for rejection of the equipment.

B. Warranty

1. A written suppliers warranty shall be provided for the equipment specified in this section as required in Section, 01740 Warranties and Bonds.

1.5 MANUFACTURERS SERVICE REPRESENTATIVE

A. Manufacturer's Representative. In accordance with the requirements of Section 01660, a Manufacturer's Representative shall be present at the site or classroom designated by the OWNER to provide the services and minimum person-days listed below, travel time excluded.

1. 2 person-days for installation assistance and inspection,

2. 3 person-days for functional, operational and performance testing

3. 1 person-days for pre-startup training of OWNER's personnel.

PART 2 PRODUCTS

2.1 GENERAL

A. Existing conveyors (14-ME-01-DWS and 14-ME-02-DWS) shall be modified to meet the requirements shown on the Drawings. At a minimum, the two discharge chutes and slide gates on each conveyor shall be replaced with new, one additional new discharge chute and slide gate shall be added as indicated the Drawings. The drive unit including motor and gear reducer shall be replaced, the liner shall be replaced and the supports shall be replace to accommodate incline of the increased angle of the conveyor as shown on Drawings.

2.2 MATERIAL/PRODUCT "A"

A. General

B. Performance requirements

1. Conveyors shall be designed for the following performance and design requirements:

Conveyor tag numbers. 14-ME-01-DWS 14-ME-03-DWS 14-ME-04-DWS

	14-ME-02-DWS			
New or existing	Existing to be Modified	New	New	
Screw conveyor type.	Shaftless	Shaftless	Shaftless	
Design capacity (wet).	6600	6600	6600	lb/hr
Minimum screw diameter.	12	9	9	in
Type of solids	Belt filter press	Belt filter press	Belt filter press	
Percent solid sludge	18	18	18	%
Material density	60	60	60	Lb/ft^3
Approximate length.	63	52	54	ft
Maximum allowable fill factor at design capacity.	N/A	40	40	%
Maximum screw speed.	20	20	20	rpm
Angle of incline.	5	0	0	deg
Motors.				
Minimum size.	5	3	3	hp
Reversing.	No	No	No	
Support design live load.	75	75	75	psf
Slide gate quantity	4	0	0	

C. Materials of construction

Flights.	304L stainless steel or high tensile strength steel
Trough and cover.	304L stainless steel
Conveyor supports.	Hot-dipped galvanized steel304L stainless steel
Discharge chute.	Hot-dipped galvanized steel304L stainless steel
Slide gates.	304L stainless steel
Fasteners: bolts, nuts, washers, etc.	Stainless steel

D. Construction. Each screw conveyor shall consist of troughs, covers, bearings, shaft seals, drives units, and support structure.

Conveyor manufacture shall provide safety equipment and safety guards as required by OSHA and as indicated in ASME B20-1, Safety Standards for Conveyor and Related Equipment. Unless otherwise indicated, safety guards shall be in accordance with the General Equipment Stipulations section.

Conveyor configuration shall be based on the Drawings. The Contractor shall coordinate the conveyor dimensions with equipment specified elsewhere. The Contractor shall be responsible for taking field measurements. All components required for existing conveyor modification and new conveyors shall be provided through the same manufacturer.

1. Conveyor Supports. Each new and existing conveyor shall be furnished complete with supports suitable for mounting as required by the supplier's design. At a minimum, each screw conveyor trough shall have supports at the drive end and the tail end of the trough plus intermediate supports at a maximum of 12 foot intervals. All shop welding shall conform to the latest standards of American Welding Society (AWS). The supports shall be designed to avoid interference with other equipment or equipment supports. The supports shall be designed to prevent excessive vibration of any portion of the conveyor unit under all loading conditions.

   Conveyor supports shall be designed for a minimum live load as specified herein. All structural supporting members shall be designed such that the ratio of the untraced length to least radius of gyration (slenderness ratio) shall not exceed 120 for any compression member and shall not exceed 240 for any tension member (of angles about Z-Z axis). In addition, all structural members and connections shall be designed so that the unit stresses will not exceed the AISC allowable stresses by more than 1/3 when subject to loading of twice the maximum design operating torque of the screw conveyor drive motors.

2. Flighting. Shaftless screw conveyors shall consist of spiral flighting only attached to a flanged connecting plate. Spiral flighting for the shaftless screw conveyors shall be designed to convey material without a center shaft or hanger bearings.

   Each screw conveyor shall be provided with inner spirals where recommended by the manufacturer, and outer spirals to increase axial strength and capacity. Conveyors shall have an inner flight thickness shall not be less than 3/4 inch and outer flight thickness shall not be less than one inch. Minimum cross sectional area for conveyors having a diameter smaller than 15 inches shall be 2.9 in^2 and conveyors having a diameter of 15 inches and larger shall be 4.3 in^2. The spiral flights shall be designed for the maximum torque requirements of the equipment specified. The "spring effect" of the spiral shall not exceed 30 mils per foot of length assuming the conveyor is completely full (100% fill factor) of the material specified herein. Flights shall be formed from cold spring steel having a minimum 72,000 psi tensile strength and a minimum 220 Brinell hardness.

   Spiral flighting shall have full penetration welds at all splice connections. The flights shall be aligned to assure true alignment when assembled and shall be made according to the manufacturer's recommendations. The connection of the spiral to the drive system shall be through a flanged connection plate that is welded to the spiral and shall form a smooth and continuous transformation from the flange plate to the spiral. The drive shaft shall have a mating matching flange and shall be bolted to the spiral connection plate.

3. Troughs shall be U-shaped and shall conform to Conveyor Equipment Manufacturers Association (CEMA) 300. Troughs shall be minimum 1/8 inch thick and shall be equipped with inlet and discharge flanged connections where indicated on the drawing. The outlet openings in the trough bottom shall be sized to prevent screw conveyor plugging. The portion of each trough that is not

covered by the inlet opening shall be covered. Covers shall conform to CEMA 300 and shall be bolted and gasketed to the conveyor. The covers shall be manufactured in four feet or less lengths to allow for access. Stiffeners shall be placed across the top of the trough and fastened to both sides of the trough to maintain trough shape and act as a seal face for the covers. A continuous neoprene gasket shall be applied to entire top face of trough top flange and stiffeners. Support saddles shall be provided on the bottom of the troughs where indicated on the Drawings or as recommended by the manufacturer. Maximum spacing shall be 12 feet.

Wear liners shall cover the bottom 180 degrees of the trough. Wear liners shall be ultra high molecular weight (UHMW) polyethylene. The wear liners shall be manufactured in sections four feet or less to allow for replacement. Holddown bars shall be provided to minimize vertical movement of the flights.

Flushing connections shall be provided. Connection location shall be coordinated with the Contractor. The flushing connection shall be a minimum 1 inch NPT, welded to the trough.

Drain connections shall be provided. Connection location shall be coordinated with the Contractor and field routed to the nearest floor drain. The drain connection shall be a minimum 4 inch flanged, welded to the trough.

4. All stainless steel shall be pickled in accordance with ASTM A380 at the mill before being shipped.

   All stainless steel surfaces shall be adequately protected during fabrication, shipping, handling, and installation to prevent contamination from iron or carbon steel objects or surfaces. Particulate matter shall be removed from piping and welds. Welds shall be either mechanically cleaned or pickled or passivated.

E. Drive Units. Each conveyor shall be driven by an electric motor through a direct drive gear reducer. Drive units shall be designed for 24 hour continuous service.

1. Gear reducers shall be a totally enclosed unit with oil or grease lubricated, rolling element, antifriction bearings throughout. Gear reducers shall be AGMA Class II, single or double reduction, helical gear units with high capacity roller bearings. Bearings shall be designed for the maximum thrust during startup of a converyor completely full (100 percent fill factor) of the material specified herein, and shall have a minimum ABMA L_{10} Life Rating of 100,000 hours. The reducers shall be standard air-cooled units with no auxiliary cooling allowed. The gear housing shall be of 30,000 psi cast iron, with removable inspection cover(s), oil breather(s), oil level indication, fill and drain holes with plugs; gearing lubricated through an oil bath for the mounting position and inclination required. The gear reducer shall be sized with a torque service factor of 1.5 based on motor nameplate, at the driven (output) shaft speed, whichever is greater. Gear motors in which the motor is integral with the gear reducer is not acceptable.

2. Electric Motors. The design of the electric motors shall be as specified in Low Voltage Motors section. When required, reversing type motors shall be provided. Maximum motor speed shall be 1800 rpm.

F. Accessories

1. New and Replaced Chutes. Inlet and discharge chutes shall be provided where indicated on the Drawings. Chutes shall be a minimum 10 gage thickness. Chutes sides shall not be sloped more than 70 degrees. Chutes shall be lined with 1/4 inch thick UHMW polyethylene, when chute sides are sloped. Deflector plates shall be attached to the inside of the chutes to limit falling velocities, when the material drop is greater than 4 feet. Deflector plates shall not be sloped more than 70 degrees. Chutes connected to the screw conveyor shall be flanged to match the conveyor connection.

2. Flexible Connections. Connections between screw conveyors and equipment shall be provided with flexible connections where indicated on the Drawings. The flexible connections shall be flanged, fabricated from reinforced neoprene or Hypalon and shall have a 6-inch laying length. Stainless steel bolts with stainless steel retainer plates shall be provided at each end of flexible connections. Flexible connections shall be designed to accommodate lateral and vertical movements of not less than 3/8 inch,

3. Automatic Lubrication. 14-ME-04-DWS shall be provided with an automatic lubrication system. The conveyor bearing shall be served with its own separate automatic grease lubrication system. The grease system shall automatically provide a continuous supply of lubricant to each bearing. Lubricant for intermediate bearings shall enter the bearing from the top with the lubrication line enclosed within the intermediate bearing support housing to prevent damage. Tubing shall be 1/4 inch stainless steel.

4. Slide Gates. Flanged drip-less slide gates shall be provided for the screw conveyor discharge openings where indicated on the Drawings. Gate surfaces in contact with the conveyed material shall be constructed of minimum 1/4 inch thick Type 304 stainless steel. All other surfaces shall be constructed of 1/4 inch thick, steel or Type 304 stainless steel materials. All welding shall be per AWS standards. The gate blade shall be constructed of Type 304 stainless steel. The gate blade shall be supported on 1-1/4 inch stainless steel rollers, which are located out of the material flow. The rollers will include bronze bushings, which require no lubrication. The gate blade leading edge shall be beveled to facilitate its travel through the material being handled. The gate shall be provided with a ramping mechanism to help force the gate blade against the seal. The retract frame shall incorporate expanded metal guards for safety purposes.

   Gate wiping seals shall be made of UHMW polyethylene. The seals shall contact the top of the gate blade along the perimeter of the throat opening. The seals shall be retained by a bolted steel bar which forms the inlet throat lining of the slide gate.

   Contractor shall provide all supports for the actuator. Supports shall resist all loads imposed by the actuator, including thrust during operation.

   a. Pneumatic Actuator. The slide gates shall have single acting-spring return air cylinder actuators with exhaust mufflers and speed control valves. Cylinder type actuators shall be provided by the valve manufacturer. Cylinder type actuators shall provide satisfactory operation with dry, oil free instrument air at 80 psig pressure and shall be shop tested at 240 psig.
   b. Cylinder type actuators shall consist of a heavy-duty, front head-mounted single acting-spring return pneumatic cylinder, constructed to ANSI specified dimensions for interchangeability. Each cylinder shall include

hard, chrome-plated rod; long-wearing, double seal configuration; and a heavy steel cylinder tube. Each cylinder shall be clevis mounted to the slide gate blade.

c. The valve actuator mechanism coupled to the cylinder shall be totally enclosed. The cylinder shall be rigidly secured to the mechanism housing and shall not pivot, rotate, or swing during operation. The cylinder piston rod shall be enclosed in the mechanism housing and shall not be exposed to view. The cylinder type actuator shall be configured such that on power failure, the spring shall drive the valve open or closed as determined by the Dryer System Supplier based on the functional requirements of the system. Each actuator shall be furnished with a 3 way solenoid valve. A flow control valve shall be furnished and installed in the solenoid valve vent.

d. Air piping, isolation, and two-way diversion solenoid valves shall be pre-mounted on the gate. Valves shall be provided in air lines to allow for speed adjustment for opening the slide gate. Air shall be supplied from the plant compressed air supply. Solenoid valves shall be single coil rated 120 volt ac and shall be energized to open or close the slide gate valve as determined by the Dryer System Supplier based on the functional requirements of the system.

e. Each gate shall include one pair of limit switches, spdt, 316 stainless steel NEMA Type 4X enclosure suitable for use in a NEC Class II, Division 2, Group G area, mounted to the gate retract frame to provide remote Open/Close position indication. The Dryer System Supplier shall provide all supports for the actuator. Supports shall resist all loads imposed by the actuator, including thrust during operation.

G. Controls. Motor starters and other controls not specified herein shall be furnished under the Electrical section. Each panel shall include an external padlockable operating handle to control the motor starter circuit breaker. A control power transformer sized for all connected loads, with both primary leads and one secondary lead fused and the other secondary lead grounded, shall be provided. A local-off-remote switch, start push buttons for both forward and reverse, stop push button, green run indicating lights for both forward and reverse and red stopped indicating light shall be mounted on the panel face. Switches shall be rated NEMA 4X. The panel shall include dry contact outputs rated 10 amperes at 120 volts ac for remote indication of:

Conveyor motor running forward
Zero speed
Emergency stop switch activated
Remote control selected

The conveyor motor space heater shall be energized when the motor is not operating. The zero speed switch shall be powered from the control panel, and shall de-energize the motor starter if energized while the conveyor is not running. The conveyor shall shut down when the emergency stop switch is activated. Shut down by any safety or equipment protection devices shall require reset at the control panel.

Terminals for all control signal and 120 VAC connections shall sized for minimum No. 12 AWG wire.

1. Conveyor Mounted Switches. Conveyor mounted switches shall be furnished with standard watertight covered terminal strip junction box and 1/2 inch threaded conduit connection. Each switch shall be furnished and mounted as an integral

part of the conveyor equipment and framework. All switches shall have 10 ampere, 115/120 volt ac, 60 Hz, rating.

2. Zero Speed Switch. A zero speed switch shall be provided on the conveyor to detect loss of speed. The zero speed switch shall be of the noncontacting type. The zero speed switch shall provide a contact output which opens to indicate zero speed and automatically resets or closes when the machine is operating. The zero speed switch shall be coordinated to properly operate over the full speed range of the driven equipment.
3. Emergency Stop Switches. Screw conveyors shall be equipped with two emergency stop safety switches, each with two normally closed double break contacts. Contacts shall be manually reset. Switches shall be equipped with a latching mechanism and a weight and cable along the length of the conveyor for operation of the switch. Switches shall be opened by cable linkage mounted on all sides of the conveyor. Cables shall be plastic covered metal cable (blaze orange color) and shall be located along the conveyor within easy reach of operating personnel who may be maintaining or observing the operating conveyor.

H. Spare parts

Spare Part	Quantity
Flight section. (New only)	20 ft section of each size
Drive shaft and coupling plate. (New only)	One of each size
Packing gland sets. (New and existing)	One of each size
Wear liner (New and existing)	One 4ft section of each size

I. Protective Coating

1. Materials and equipment shall be coated in accordance with Section 09900 Painting and Coatings.

J. Manufacturers

1. MANUFACTURER's Experience: The materials and equipment covered by this specification are intended to be standard materials and equipment of demonstrated successful performance and supplied by a manufacturer who has been actively engaged in the supply of similarly sized conveyors for a minimum of 5 years. Equipment shall be designed and constructed in accordance with the highest standards of the industry and shall be installed in accordance with the MANUFACTURER's recommendations and the Contract Documents.

2. Unit Responsibility:

3. Manufacturers or Equal:

   a. JDV Equipment Company
   b. Spirac
   c. Custom Conveyor
   d. KWS Manufacturing Co.

PART 3 EXECUTION

3.1 DELIVERY AND STORAGE

A. A complete set of MANUFACTURER's instructions covering storage, installation, operation, lubrication, and maintenance shall be furnished to the OWNER no later than the date the equipment is shipped. Care during storage and procedures for installation, lubrication, and startup of the equipment and motors shall be in strict conformance with the MANUFACTURER's instructions.

3.2 INSTALLATION

A. Install in accordance with the MANUFACTURER's printed instructions.

3.3 TESTING

A. General

1. Prior to startup, all equipment described herein shall be inspected for proper alignment, quiet operation, proper connection, and satisfactory performance as determined by means of a functional test. Any equipment or components that fail this functional test shall be repaired or replaced by the Contractor at no cost to the Owner and re-tested.

2. Following the functional tests, the equipment shall be tested to confirm it can meet the specified performance and design requirements.

3. Tests shall be witnessed by Engineer. Owner shall be reimbursed by Contractor for all costs of subsequent visits by Engineer to witness or observe incomplete tests, retesting, or subsequent tests

B. Performance Testing

1. Performance testing of the full-scale equipment shall be required in accordance with Section 01660 Testing and Training.

3.4 SUPPLEMENTS – NOT USED

3.5 TRAINING

A. The manufacturer's representative shall provide training for the Owner in proper operation and maintenance of the equipment.

END OF SECTION

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SECTION 14600 – HOISTS, CRANES AND WINCHES, GENERAL

PART 1 GENERAL

1.1 THE REQUIREMENT

A. The CONTRACTOR shall furnish, install, and place in satisfactory operation the hoisting equipment and appurtenances complete with all necessary safety equipment, in accordance with the requirements of the Contract Documents.

B. The CONTRACTOR shall furnish and install the tracks, ancillary steel, and appurtenances necessary for all monorail hoists and bridge cranes shown.

1.2 REFERENCE SPECIFICATIONS, CODES, AND STANDARDS

A. Standards

1. AISC Specifications for the Design, Fabrication, and Erection of Structural Steel for Buildings

2. AGMA American Gear Manufacturers Association

3. ANSI B30.11 Overhead and Gantry Cranes (Top Running Bridge, Single or Multiple Girder, Top Running Trolley Hoists)

4. ANSI B30.16 Portal, Tower, and Pillar Cranes

5. ANSI MH 27.1 Specifications for Underhung Crane and Monorail Systems

6. ASTM A 36 Specification for Structural Steel

7. CMA Crane Manufacturer's Association of America

8. NEMA National Electrical Manufacturers Association

B. Specifications

1. Section 11150 – Submersible Propeller Pumps

2. Section 11205 – Submersible Compact Mixers

3. Section 11206 – Submersible Low Speed Mixers

1.3 CONTRACTOR SUBMITTALS

A. General: CONTRACTOR shall submit administrative, shop drawings, samples, quality control, and contract closeout submittals of all equipment furnished this Section and in referenced Sections in accordance with the requirements of Section 01340 Shop Drawings, Product Data and Samples.

B. Shop Drawings and Samples: The CONTRACTOR shall submit complete shop drawings of all hoist and crane equipment in accordance with the requirements of the Section 01340 – Shop Drawings, Product Data and Samples Such shop drawings shall

include all electrical requirements, weights, wheel loads, dimensions, and clearances required.

C. O & M Manuals: The CONTRACTOR shall provide operators and maintenance data for all equipment furnished for the project in accordance with Section 01730, Operation and Maintenance Data.

D. Tools: Special tools necessary for maintenance and repair of the equipment shall be furnished as a part of the WORK hereunder; such tools shall be suitably stored in metal tool boxes, and identified with the equipment number by means of stainless steel or solid plastic name tags attached to the box.

E. Quality Assurance: CONTRACTOR shall submit the following:

1. Manufacturer's Certificate of Proper Installation

2. Functional Test Certification

3. Factory performance test reports

4. Special shipping, storage and protection, and handling instructions

5. Manufacturer's printed installation instructions

6. Suggested list of spare parts to maintain the equipment in service for a period of 5 years. Include a list of special tools required for checking, testing, parts replacement, and maintenance.

7. List of special tools, materials, and supplies furnished with equipment for use prior to and during startup.

1.4 MANUFACTURERS SERVICE REPRESENTATIVE

A. Manufacturer's Representative. In accordance with the requirements of Section 01660, a Manufacturer's Representative shall be present at the site or classroom designated by the OWNER to provide the services and minimum person-days listed below, travel time excluded.

1. 1 person-days for installation assistance and inspection,

2. 1 person-days for functional and performance testing

3. 1 person-days for pre-startup training of OWNER's personnel.

PART 2 PRODUCTS

2.1 GENERAL

A. Number of complete portable davit crane, winches, mounting sockets and all other required equipment for a complete lifting system:

1. Oxidation Ditch 1

a. Propeller Pumps: 1 davit crane system, 2 mounting sockets

b. Compact Mixers: 0 davit crane systems, 1 mounting socket
c. Low Speed Mixers: 2 davit crane systems, 6 mounting sockets
d. Other Installed Sockets: As shown on the Drawings

2. Oxidation Ditch 2

a. Propeller Pumps: 1 davit crane system, 2 mounting sockets
b. Compact Mixers: 0 davit crane systems, 1 mounting socket
c. Low Speed Mixers: 2 davit crane systems, 6 mounting sockets
d. Other Installed Sockets: As shown on the Drawings

3. Aeration Basin 3

a. Propeller Pumps: 1 davit crane system, 1 mounting socket
b. Compact Mixers: 0 davit crane systems, 1 mounting socket
c. Low Speed Mixers: 1 davit crane system, 4 mounting sockets
d. Other Installed Sockets: As shown on the Drawings

4. Aeration Basin 4

a. Propeller Pumps: 1 davit crane system, 1 mounting socket
b. Compact Mixers: 0 davit crane systems, 1 mounting socket
c. Low Speed Mixers: 1 davit crane system, 4 mounting sockets
d. Other Installed Sockets: As shown on the Drawings

5. Secondary Clarifier No. 3

a. Walkway: 1 davit crane system, 1 mounting socket

6. RAS Pump Station North

a. Staircase: 1 davit crane system, 1 mounting socket
b. Sump Pumps: 1 davit crane system, 1 mounting socket

B. The CONTRACTOR or EQUIPMENT SUPPLIER shall furnish and install all hoist, winches, and crane equipment specified. Equipment of similar design shall be from the same manufacturer.

C. The CONTRACTOR and EQUIPMENT SUPPLIER shall coordinate the scope of equipment supply and the davit crane systems to supply a complete, integrated, and operable system.

D. The CONTRACTOR and EQUIPMENT SUPPLIER shall verify all dimensions and clearances as shown on the Drawings and in the field, where possible, prior to procurement to confirm all components, including lift wire lengths and wire management, are a proper fit for the application and operation of the equipment.

E. The CONTRACTOR shall verify all dimensions and clearances in the field prior to erection and shall be responsible for the proper fitting and operation of the equipment.

F. Functionality

a. Lift Capacity: davit crane shall have a variable lift capacity based on boom length, to vary between 2000 pounds (907 kg) lift capacity with the boom in the shortest

length when positioned at 45 degrees from vertical, and 1100 pounds (498 kg) with the boom fully extended and in the horizontal position.

b. Hook Reach: boom shall telescope up to 4 different lengths with a minimum hook reach of 28 inches (711 mm) in the shortest position and a maximum hook reach of at least 82 inches (2082 mm) with the boom fully extended, measured from mast center to hook center.
c. Hook Height: hook height shall be adjustable by moving the boom up or down between horizontal and 45 degrees from vertical, with a minimum of 54 inches (1370 mm) between the lowest position and the highest position with the boom fully extended.
d. Boom Angle: boom angle shall be adjustable with a hand operated screw jack acting to raise or lower the boom between horizontal and 45 degrees from vertical.
e. Boom Sheave: wire rope shall pass over a sheave at the end of the boom. Sheave shall have a bronze bearing, and shall be supported by a machined clevis pin which shall be keyed to the boom to keep the pin from rotating.
f. Rotation: mast and boom shall rotate 360 degrees in the base on a pin bearing in the bottom of the base, with a rotational handle attached to mast to facilitate rotation. Crane shall include a Nylatron bearing sleeve to support the mast at the top of the base.
g. Fastening Pins: crane components shall be fastened together using stainless steel clevis style pins, secured with lynch pins with lanyards fastening the lynch pins to primary structural components.
h. Portability: davit crane shall break down into portable components with no single component weighing more than 75 pounds (34 kg). Carrying handles shall be welded to mast and boom.
i. Winch Location: lifting winches shall be located such that the center point of the drive shaft is behind the centerline of the mast.
j. Winch Mounting Bracket: crane shall be equipped with a winch mounting bracket that connects to the boom with a quick connect pin allowing the winch to be attached or removed without tools. Winch shall attach to the bracket using standard fasteners.
k.
l. Nametag: davit crane shall be labeled with a non-corrosive metal identification plate labeled or imprinted with the manufacturer’s name, model number and serial number.

G. Materials

a. Winch: winch shall have a Quick Disconnect cable anchor, and a positive load holding mechanical brake able to stop and hold the load automatically when operation is halted.
b. Base/Mounting Sockets: Shall be capable of supporting the hoist and associated loads. Base/Mounting sockets shall be of the same manufacturer as the hoist system.
c. Material and Finish for Crane and Base: steel meeting ASTM standards. AISI 304/304L stainless steel.
d. Wire Rope: wire rope with swivel hook and swaged ball fitting. Wire rope construction shall 7 x 19 type 304 stainless steel cable.

H. Accessories

a. Base Extension: to extend mast to provide additional 15 inch (380 mm) hook height and maintain lift capacity.
b. Rotational Roller Bearing and Positional Lock: to improve 360 degree crane rotation and provide multi-position lock to keep crane from rotating.
c. Headache Ball: to apply tension to wire rope when crane is not under load.

I. Manufacturer, Or Equal

a. Crane: Commander 2000 Series, 5PT20 Portable Davit Crane.
b. Winch: Winch shall be a 4WP2-K electric winch (115/1/60 VAC).
c. Base/Mounting Sockets: Crane 5BP20 Pedestal Base, 5BF20 Flush Mount Base, or 5BW20 Wall Mount Base as indicated on the Drawings.
d. Material and Finish for Crane and Base: steel meeting ASTM standards. AISI 304/304L stainless steel.
e. Wire Rope: wire rope with swivel hook and swaged ball fitting. Wire rope construction shall 7 x 19 type 304 stainless steel cable. All hooks shall be safety type with latch.

2. Adjustable Hoist

a. Provide one (1) hoist having a 25 ft lifting height, a minimum 42 inch reach, a 60 inch mast height, and a minimum 500 pound lifting capacity. The hoist shall be mounted into a wall mount socket as described below. The hoist shall be easily removed from the hoist base to facilitate moving to another location or for storage. The boom, mast and base shall be of 304 or 316 stainless steel construction.
b. The hand winch shall be of high-grade carbon steel construction having cadmium or zinc plate finish. An anchor hole in the flange of the drum shall provide easy attachment and removal of the lifting chain to allow the chain assembly to be attached to a cleat while the hoist is moved to a new location. An automatic friction brake shall be provided to prevent the winch load from freewheeling. The winch handle shall be an integral part of the braking mechanism.
c. The mounting socket shall be capable of supporting the hoist and associate loads.

J. Motors: Motors shall be TENV or TEFC and comply with the requirements of Section 16220 – Low Voltage Motors.

2.2 BASIC MATERIALS

A. All materials used must be new and of the best commercial grade. Where materials are not specified, the CONTRACTOR shall have the manufacturer use the most suitable selection for the given application and environment.

2.3 PLANT FABRICATED ITEMS

A. All fabrication, assembly, and welding shall be carried out by factory-trained specialists and certified welders.

PART 3 EXECUTION

3.1 GENERAL REQUIREMENTS

A. All hoist and crane equipment shall be installed in strict accordance with the manufacturer's printed instructions and the CONTRACTOR shall arrange to have all installation performed under the guidance of the manufacturer's field representative.

3.2 WORKMANSHIP

A. The workmanship shall be in accordance with the referenced standards and codes.

3.3 INSTALLATION; CONSTRUCTION; APPLICATION; ERECTION; ETC.

A. Care shall be taken, that the structural integrity of beams, columns, walls, floors, and roofs will be maintained at all times.

3.4 EXECUTION OF TEST PROCEDURES; VALIDATION; ETC.

A. After completion of the WORK, the CONTRACTOR shall test all hoist and crane equipment in the presence of the manufacturer's field representative, who shall certify in writing that the equipment meets all applicable standards and specifications.

END OF SECTION

SECTION 14630 –BRIDGE CRANE

PART 1 GENERAL

1.1 THE REQUIREMENT

A. The Contractor shall furnish and install an electrically operated bridge crane system complete, in accordance with the requirements of the Contract Documents. The bridge crane shall be of the low headroom type, equipped for electric lift and travel in both directions and it shall be mounted on standard I-beams, or specially fabricated sections.

B. Two bridge cranes shall be installed in the Blower Building and one bridge crane shall be installed in the Biosolids Dryer Building. These buildings shall be designed, coordinated, and constructed in accordance to Section 13340. The Contractor shall be responsible for the overall coordination between the bridge crane supplier and the metal buildings in which they will be installed.

C. Related Sections:

1. Section 01340 – Shop Drawings, Product Data and Samples
2. Section 05120 – Structural Steel.
3. Section 09900 – Painting and Coatings
4. Section 13340 – Metal Building System
5. Section 16000 – Common Work Results for Electrical

1.2 REFERENCE SPECIFICATIONS, CODES, AND STANDARDS

Crane Manufacturers' Association of America, Inc. (CMAA):

1. Specification Number 70 - Specifications for Electrical Overhead Traveling Cranes.
2. Specification Number 74 - Specifications for Top Running and Under-Running Single Girder Electric Overhead Traveling Cranes.

Hoist Manufacturers' Institute (HMI):

1. HMI 100 - Specification for Electric Wire Rope Hoists.

American Society of Mechanical Engineers (ASME):

1. ASME B 30.2 - Standard for Overhead and Gantry Crane.
2. ASME B 30.11 - Safety Standard for Monorails and Underhung Cranes.
3. ASME B30.17 - Overhead and Gantry Cranes (Top Running Bridge, Single Girder, Underhung Hoists).

Occupational Safety and Health Administration (OSHA).

National Electrical Code (NEC)

American Welding Society (AWS)

- AWS D1.1 – Structural Welding - Steel
- AWS D14.1 – Specification for Welding of Industrial and Mill Cranes and Other Material Handling Equipment

1.3 CONTACTOR SUBMITTALS

A. General: Contractor shall submit administrative, shop drawings, samples, quality control, and contract closeout submittals of all equipment furnished this Section and in referenced Sections in accordance with the requirements of Section 01340 Shop Drawings, Product Data and Samples.

B. Shop Drawings and Samples: In addition to the requirements of Section 01340, Contractor shall submit the following:

1. Dimensional drawings and other construction details, including materials of construction, equipment weights, electrical connection diagrams, and schematics showing electrical control or power requirements.

C. O & M Manuals: The CONTRACTOR shall provide operators and maintenance data for all equipment furnished for the project in accordance with Section 01730, Operation and Maintenance Data.

1. Product Data: Parts, devices, and accessories including special safety and control devices.

D. Tools: Special tools necessary for maintenance and repair of the equipment shall be furnished as a part of the WORK hereunder; such tools shall be suitably stored in metal tool boxes, and identified with the equipment number by means of stainless steel or solid plastic name tags attached to the box.

E. Manufacturer's Installation Instructions.

F. Design Data: Structural and seismic calculations for runway beams, rails, bridge beams, and anchor bolts.

G. Certificates:

1. Certificate of tests conducted by the crane manufacturer in accordance with industry standards and federal regulations prior to shipment of equipment.

2. Occupational Safety and Health Administration certificate upon completion of field load testing.

H. Operation and Maintenance Data.

1.4 QUALITY ASSURANCE

A. Contractor shall submit the following:

1. Manufacturer's Certificate of Proper Installation

2. Functional Test Certification

3. Special shipping, storage and protection, and handling instructions

4. Manufacturer's printed installation instructions

5. Suggested spare parts to maintain the equipment in service for a period of 15 years. Include a list of special tools required for checking, testing, parts replacement, and maintenance.

6. List of special tools, materials, and supplies furnished with equipment for use prior to and during startup.

B. Supplier Qualifications: Willing and capable of furnishing every system component, including trolley, hoist, bridge crane girders, bridge crane girder cross bracing, end trucks, runways, rails, restraint bracing, end stops, hangers and hanger connections to beams, complete electrification and reels, and accessories.

C. Installer Qualifications: Manufacturer approved installer of products similar to specified products on minimum 5 projects of similar scope with satisfactory performance record.

PART 2 PRODUCTS

2.1 GENERAL

A. The Bridge crane system shall be controlled from a Pendant controlled pushbutton station and be furnished complete with all required safety devices and overload protection. The power supply shall be from enclosed, UL-approved conductor bar systems. The rails shall be standard I-beams, or specially fabricated steel sections, firmly anchored to the structure in accordance with AISC design manual recommendations. The track deflection shall not exceed 1/800 of the span, or 1-1/4 inches, whichever is less. The complete crane system, except the tracks, shall be the product of one crane manufacturer regularly engaged in the manufacture of such equipment.

B. The Bridge crane system shall be designed to be compatible with the buildings in which they will be installed, in accordance to Section 13340. Metal buildings shall be designed in accordance Section 13340 and shall account for all bridge cranes.

2.2 TOP RUNNING OR UNDERHUNG BRIDGE CRANE

A. Performance Requirements: Underhung or Top Running traveling bridge crane system with electric motor-driven bridge and electric motor-driven trolley and hoist, based on the following values:

Location	Blower Building – Pump Maintenance Shop	Blower Building – Blower Room	Biosolids Dryer Building
Capacity	2 tons	2 tons	6 tons
Span (center to center crane runway)	12’	19.5’	61.5’
Elevation of hook in highest position, not lower than	75.75	71.92	80.96
Elevation of hook in lowest position, not higher than	60.75	60.75	54.96
Elevation of operating floor (floor slopes), approximate position	59.75	59.75	52.96
Approximate hoisting speed	14 feet per minute	14 feet per minute	19 feet per minute
Approximate travel speed of trolley	30 feet per minute	30 feet per minute	45 Feet per minute
Approximate travel speed of bridge	65 feet per minute	65 feet per minute	65 feet per minute
Hoist motor, minimum	2 horsepower	2 horsepower	10 horsepower
Trolley motor, minimum	½ horsepower	½ horsepower	(2) 1/2 Horsepower
Bridge motors, minimum	(2) 1/2 horsepower	(2) ½ horsepower	(2) 3/4 horsepower

B. Cranes shall conform to CMAA #74 or HMI Service Class H2 for infrequent use. Assemble, paint, test, and adjust equipment before shipment as far as practical. Arrange working parts for convenient inspection, lubrication, adjustment, repair, or replacement.

C. The extent of hook travel shall be in accordance with the hook travel area shown on the Contract Drawings.

2.3 RUNWAYS AND BRIDGE

A. Runways: Structural steel as specified in Section 05120, capable of supporting crane components.

B. Bridge: Underhung or Top Running type, rigidly supported by end trucks on crane rail.

1. End Trucks: Structural steel members capable of distributing loading equally to each wheel. Endtruck wheelbase must meet CMAA #74 specification.

2. Wheels: Minimum 5 inch diameter; double flanged (may be single flanged if crane is of the underhung type) with rotating axles and safety lugs; forged steel, hardened to 425 Brinell fitted with anti-friction bearings with seals and grease fittings.

3. Stops and Bumpers: Capable of absorbing energy and stopping moving bridge at end of travel.

2.4 BRIDGE DRIVE UNIT

A. Type: Single-speed, adjustable torque cushioned start, motor-driven CMAA-4 units at ends of bridge. Tractor type drives are not acceptable.

B. Speed Reducers: Oil-lubricated with oiltight cases.

C. Shaft Bearings: Anti-friction.

D. Bridge Brakes:Provide bridge with electromechanical brake conforming to the requirements of CMAA #74.

E. Motors: Specially designed and constructed for crane service; 460 volt, 3 phase, 3 wire, TENV type, operating at 1,800 revolutions per minute maximum, with Class B or Class F insulation.

2.5 TROLLEY AND HOIST

A. Trolley Drive: Trolley drive motors shall be AC inverter duty TENV or TEFC, 30 min duty, with class F insulation and have electromechanical brake. Tractor drive units are not acceptable.

1. Trolley Head Wheels: Minimum 4-inch diameter wheels with safety lugs.

2. Stops and Bumpers: Capable of absorbing energy and stopping moving trolley when at end of travel.

B. Hoist: HMI Duty Service Classification H2 (Standard); The hoist shall be double reeved electric wire type. Equip hoist with an electromechanical holding brake and a mechanical load brake.

1. Load Break: Weston screw & disc type self-actuating load brake running in an oil bath. The brake can hold a full capacity load independent of the motor brake and assures that load does not accelerate while being lowered.

2. Hoisting Drum: Steel or cast iron with machined grooves to depth equal to 1/2 rope diameter; capable of retaining at least 2 complete wraps of rope with hook in lowest position and accommodating full rope length without overlapping when hook is in highest position. The drum grooves shall be left and right hand type.

3. Hoisting Rope: Specifically designed for specified service loads; preformed, improved plow steel with independent wire rope core; double-reeved.

4. Hoisting Block: Steel with hook supported on ball or roller bearings.

5. Hoisting Block Hook: Forged or rolled steel freely rotating on bearing support and with heavy-duty type safety latches.

C. Drive Speed Reducers: Oil-lubricated heat-treated steel helical gears with oil tight cases, and shafts running in anti-friction bearings.

D. Drive Motors: Hoist drive motor shall be AC inverter duty TENV or TEFC, 30 min duty, with Class F insulation and have electromechanical brake. Specially designed and constructed for crane service; 460 volt, 3 phase, 3 wire, TENV squirrel-cage induction type, operating at 1,800 revolutions per minute maximum, with Class B or Class F insulation.

2.6 PROTECTIVE COATING

Materials and equipment shall be coated in accordance with Section 09900 Painting and Coatings and the Contract Documents.

2.7 ELECTRICAL AND CONTROL

A. Electrification:

1. Provide flat festooned cable system to bridge and runway for electrification. Control Voltage: 120 volts alternating current, supplied from a transformer on the hoist.

B. Control:

1. The cranes shall be controlled by a pendant station suspended from an independent festoon system. The pendant shall be capable of controlling hoist speed, trolley travel, and bridge travel. All controls shall be two speed variable frequency drives. Control enclosure shall be NEMA 12.

2. Unit Type: Pendant, momentary-contact, maintain-pressure type, automatically de-energizing, 2-speed push-button stations hanging from hoist and attached to bridge, supported by a steel cable parallel to the control cable.

3. Push Buttons: Start-stop; 2 push buttons for hoisting, 1 for each direction; 2 push buttons for trolley travel, 1 for each direction and 2 for crane travel, 1 for each direction.

4. Push-button Labels: Directions of horizontal motions clearly marked on bridge or trolley and on control pendant.

5. Pendant Control Station and Other Electrical Control Enclosures: NEMA 4.

6. Hoist Limit Switches: Geared upper and lower limit switch to limit the up and down travel and a block actuated secondary upper limit switch by hook to stop hoist at highest safe point.

7. Electric Power: 480 volt, 3 phase, 60 hertz electric service with junction boxes for connection of field services and ground pad.

2.8 MANUFACTURERS

A. Single Girder Bridge Crane: One of the following or equal:

1. ACCO, York, PA.

2. Heco Pacific Manufacturing, Union City, CA.

3. Crane Works, San Leandro, CA

PART 3 EXECUTION

3.1 DELIVERY AND STORAGE

A. A complete set of manufacturer's instructions covering storage, installation, operation, lubrication, and maintenance shall be furnished to the OWNER no later than the date the equipment is shipped. Care during storage and procedures for installation, lubrication, and startup of the equipment and motors shall be in strict conformance with the manufacturer's instructions.

3.2 PREPARATION

A. Modify structures as required to install crane system.

3.3 INSTALLATION

A. Install in accordance with the manufacturer's printed instructions.

B. Install crane as specified in Sections 16000, and in accordance with manufacturer's instructions.

3.4 TOLERANCES

A. Runways, Tracks, and Girders: Alignment in accordance with CMAA #74 specification.

B. Distance between Girders: Within 1/8 inch.

3.5 TESTING

A. After complete installation of the system, test equipment with minimum 125 percent of rated capacity load.

B. Provide load and slings for tests. Remove loads and slings after tests.

C. Operate equipment through a full lift and lowering cycle, and travel of bridge and trolley to demonstrate functions of hoisting, braking, and traveling; quietly, smoothly and safely.

D. Perform tests in the presence of OSHA certified, equipment manufacturer, and Engineer.

E. Do not use hoisting equipment to handle loads until OSHA certificate has been received.

END OF SECTION

SECTION 15000 – PIPING, GENERAL

PART 1 GENERAL

1.1 THE REQUIREMENT

A. The Contractor shall provide all piping systems indicated, complete and operable, in accordance with the Contract Documents. The provisions of this Section shall apply to all piping sections in Divisions 2 and 15.

B. The Contract Drawings define the general layout, configuration, routing, method of support, pipe size, and pipe type. The Contract Drawings are not pipe construction or fabrication drawings. It is the Contractor's responsibility to develop the details necessary to construct all mechanical piping systems, to accommodate the specific equipment provided, and to provide and install all spools, spacers, adapters, and connectors for a complete and functional system. Flanges and joints in addition to those shown may be necessary to facilitate fabrication and installation, and shall be provided at one additional cost to owner.

1.2 REFERENCE SPECIFICATIONS, CODES, AND STANDARDS

A. Without limiting the generality of other requirements of these Specifications, all work specified herein shall conform to or exceed the requirements of the Building Code and the applicable requirements of the following documents to the extent that the provisions of such documents are not in conflict with the requirements of this Section; provided, that for Building Codes, the latest edition of the code, as adopted as of the date of award by the Owner having jurisdiction, shall apply to the Work.

B. This Section contains references to the following documents. In case of a conflict between the requirements of this Section and those of the listed documents, the requirements of this Section shall prevail. The latest edition of the following references at the time of bid shall be used:

ANSI/AWS D1.1	Structural Welding Code
ANSI A13.1	Scheme for the Identification of Piping Systems
AWWA M11	Steel Pipe Design and Installation Manual
MSS SP	Pipe Hangers and Supports - Materials, Design and Manufacture

1.3 CONTRACTOR SUBMITTALS

A. Shop Drawings: Submittals shall be furnished in accordance Section 01340 - Shop Drawings, Product Data and Samples. Shop Drawings shall contain the following information:

1. Drawings: Layout drawings including all necessary dimensions, details, pipe joints, fittings, specials, valves, appurtenances, anchors, guides, and material lists. Fabrication drawings shall indicate all spool pieces, spacers, adapters, connectors, fittings, and supports to accommodate the equipment and valves in a complete and functional system.

B. Samples: All expenses incurred in making samples for certification of tests shall be borne by the Contractor at no increase in cost to the Owner.

C. Certifications:

1. All necessary certificates, test reports, and affidavits of compliance shall be obtained by the Contractor.

2. Fabricator Statement: A statement from the pipe fabricator certifying that all pipes will be fabricated subject to a recognized Quality Control Program. An outline of the program shall be submitted to the Engineer for review prior to the fabrication of any pipe.

1.4 QUALITY ASSURANCE

A. General: To assure uniformity and compatibility of piping components in grooved-end piping systems, fittings and couplings shall be furnished by the same manufacturer. Like items of materials provided hereunder shall be the end products of one manufacturer in order to achieve standardization for appearance and manufacturer's service.

B. Inspection:

1. All pipe shall be subject to inspection at the place of manufacture. During the manufacture of the pipe, the Engineer shall be given access to all areas where manufacturing is in progress and shall be permitted to make all inspections necessary to confirm compliance with the Specifications.

2. The Contractor shall notify the Engineer of the production schedule in sufficient time so that factory inspection can be arranged. Factory inspection will be made after the manufacturer has performed satisfactory checks, adjustments, tests, and operations. The extent of factory inspection and testing shall be as specified herein below and in the respective piping sections of these Specifications.

3. The manufacturer shall make available for the Engineers use such gauges as are necessary for inspection. The manufacturer shall provide the Engineer with such assistance as is necessary for the handling of pipe and fittings.

4. Approval of pipe at the factory only allows the manufacturer to ship the equipment to the site, and does not constitute final acceptance by the Engineer. Unless otherwise specified, the Owner will pay for expenses incurred for the factory test witness visits. The cost of performing the tests in the factory shall be included in the Contractor’s bid.

C. Welding Requirements. All welding procedures used to fabricate pipe shall be prequalified under the provisions of ANSI/AWS D1.1. Welding procedures shall be required for, but not necessarily limited to, longitudinal and girth or spiral welds for pipe cylinders, reinforcing plates and ring flange welds, and plates for lug connections.

PART 2 PRODUCTS

2.1 GENERAL

A. Extent of Work: All pipes, fittings, and appurtenances shall be provided in accordance with the requirements of the applicable Sections of Divisions 2 and 15 and as indicated. The pipe material required for each fluid application shall be in accordance with the Pipe Schedule. Where a pipe material type is not specifically designated on the drawings, the Contractor may select among the options presented in the Pipe Schedule. When a pipe material is specifically designated on the drawings, only that material will be allowed unless approved in writing by the Engineer.

B. Pipe Supports: All pipes shall be adequately supported, restrained, and anchored in accordance with the requirements of Section 15006 - Pipe Supports, and as indicated. Where pipe support details are indicated, the supports shall conform thereto and shall be placed as indicated; provided, that the support for all exposed piping shall be complete and adequate regardless of whether or not supporting devices are specifically shown.

C. Lining: Application, thickness, and curing of pipe lining shall be in accordance with the requirements of the applicable Sections of Division 2, unless otherwise indicated. The manufacturer shall take full responsibility for the complete, final product and its application. All pipe ends and joints of lined pipes at screwed flanges shall be epoxy-coated to assure continuous protection.

D. Protective Coating: Application, thickness, and curing of pipe coating shall be in accordance with the requirements of the applicable Sections of Division 2, unless otherwise indicated. Pipes above ground or in structures shall be field-coated in accordance with Section 09900 – Painting and Coating.

E. Pressure Rating: All piping systems shall be designed for the maximum expected pressure as defined in Section 02640 - Pipeline Testing and Disinfection, or as indicated on the Piping Schedule.

F. Core Drilling: Where core drilling is required for pipes passing through existing concrete, core drilling locations shall be determined by radiograph of concrete construction to avoid damage to embedded raceways and rebars.

G. Welding Requirements: All welding procedures used to fabricate pipe shall be prequalified under the provisions of ANSI/AWS D1.1 - Structural Welding Code. Welding procedures shall be required for longitudinal and girth or spiral welds for pipe cylinders, spigot and bell ring attachments, reinforcing plates and ring flange welds, and plates for lug connections. All welding shall be done by skilled welders, welding operators, and tackers who have had adequate experience in the methods and materials to be used. Welders shall be qualified under the provisions of ANSI/AWS D1.1 by an independent local, approved testing agency not more than 6 months prior to commencing work on the pipeline. Machines and electrodes similar to those used in the Work shall be used in qualification tests. The Contractor shall furnish all material and bear the expense of qualifying welders at no increased cost to the Owner.

H. Care shall be exercised during fabrication to prevent the accumulation of weld rod, weld splatter, pipe cuttings and filings, gravel, cleaning rags, etc., within piping sections. All piping shall be examined to assure removal of these and other foreign objects prior to assembly. Shop cleaning may employ any conventional commercial cleaning method if

it does not corrode, deform, swell, or otherwise alter the physical properties of the material being cleaned.

2.2 PIPE FLANGES

A. Flanges: Where the design pressure is 150 psi or less, flanges shall conform to either ANSI/AWWA C207 - Steel Pipe Flanges for Waterworks Service - Sizes 4 In. Through 144 In., Class D, or ANSI/ASME B16.5 - Pipe Flanges and Flanged Fittings, 150-lb class. Where the design pressure is greater than 150 psi up to a maximum of 275 psi, flanges shall conform to either ANSI/AWWA C207 Class E or Class F, or ANSI/ASME B16.5 150-lb class. However, AWWA flanges shall not be exposed to test pressures greater than 125 percent of rated capacity. For higher test pressures, the next higher rated AWWA flange or an ANSI-rated flange shall be selected. Where the design pressure is greater than 275 psi up to a maximum of 700 psi, flanges shall conform to ANSI/ASME B16.5, 300-lb class. Flanges shall have flat faces and shall be attached with bolt holes straddling the vertical axis of the pipe, unless otherwise indicated. Attachment of the flanges to the pipe shall conform to the applicable requirements of ANSI/AWWA C207. The Contractor shall coordinate the flange compatibility for pipes, valves, and equipment. Where connecting to existing flanges, the Contractor shall field verify existing flange dimensions. Flanges for miscellaneous small pipes shall be in accordance with the standards indicated for these pipes.

B. Blind Flanges: Blind flanges shall be in accordance with ANSI/AWWA C207, or as indicated for miscellaneous small pipes. All blind flanges for pipe sizes 12 inches and over shall be provided with lifting eyes in form of welded or screwed eye bolts.

C. Flange Bolts: All bolts and nuts shall conform to Section 05500 – Miscellaneous Metals. Studs and bolts shall extend through the nuts a minimum of 1/4 inch. All-thread studs shall be used on all valve flange connections, where space restrictions preclude the use of regular bolts.

D. Flange Gaskets: Gaskets for flanged joints shall be full-faced, 1/16-inch thick compressed sheets of aramid fiber base, with nitrile binder and non-stick coating, suitable for temperatures to 700 degrees F, a pH of one to eleven, and pressures to 1,000 psig. Blind flanges shall have gaskets covering the entire inside face of the blind flange and shall be cemented to the blind flange. Ring gaskets shall not be permitted, unless otherwise indicated.

E. Flange Coating: All machined faces of metal blind flanges and pipe flanges shall be coated with a temporary rust-inhibitive coating to protect the metal until the installation is completed.

F. Flange Gasket Manufacturers, or Equal:

1. John Crane; Style 2160.

2. Garlock; Style 3000.

2.3 INSULATION FLANGES

A. Insulating Flange Sets: Insulating flange sets shall be provided where indicated, and as required by the Contract Documents. Each insulating flange set shall consist of an insulating gasket, insulating sleeves and washers and a steel washer. Insulated flanges shall have bolt holes 1/4-inch diameter greater than the bolt diameter. Insulating

sleeves and washers shall be one piece when flange bolt diameter is 1-1/2-inch or smaller and shall be made of acetal resin. For bolt diameters larger than 1-1/2-inch, insulating sleeves and washers shall be 2-piece and shall be made of polyethylene or phenolic. Steel washers shall be in accordance with ASTM A325 - Specification for Structural Bolts, Steel, Heat Treated, 120/105 ksi Minimum Tensile Strength. Insulating gaskets shall be full-face.

B. Insulating Flange Manufacturers, or Equal:

1. JM Red Devil; Type E.

2. Maloney Pipeline Products Co., Houston.

3. PSI Products, Inc., (Frost Engineering Service Co., Costa Mesa, California).

2.4 THREADED INSULATING CONNECTIONS

A. General: Threaded insulating bushings, unions, or couplings, as appropriate, shall be used for joining threaded pipes of dissimilar metals and for piping systems where corrosion control and cathodic protection are involved.

B. Materials: Threaded insulating connections shall be of nylon, Teflon, polycarbonate, polyethylene, or other non-conductive materials, and shall have ratings and properties to suit the service and loading conditions.

2.5 MECHANICAL-TYPE COUPLINGS (GROOVED OR BANDED PIPE)

A. General: Cast mechanical-type couplings shall be provided where indicated. The couplings shall conform to the requirements of ANSI/AWWA C606 - Grooved and Shouldered Joints. Bolts and nuts shall conform to the requirements of Section 05500 – Miscellaneous Metals. All gaskets for mechanical-type couplings shall be compatible with the piping service and fluid utilized, in accordance with the coupling Manufacturer's recommendations. The wall thickness of all grooved piping shall conform with the coupling manufacturer's recommendations to suit the highest expected pressure. To avoid stress on equipment, all equipment connections with mechanical-type couplings shall have rigid-grooved couplings, or harness sets in sizes where rigid couplings are not available, unless thrust restraint is provided by other means. All mechanical-type couplings on buried piping shall be bonded. The Contractor shall have the coupling manufacturer's service representative verify the correct choice and application of all couplings and gaskets, and the workmanship, to assure a correct installation. To assure uniform and compatible piping components, all grooved fittings, couplings, and valves shall be from the same manufacturer.

B. Manufacturers of Couplings for Steel Pipe, or Equal:

1. Gustin-Bacon (Aeroquip Corp.) (banded or grooved).

2. Victaulic Style 41 or 44 (banded, flexible).

3. Victaulic Style 77 (grooved, flexible).

4. Victaulic Style 07 or HP-70 (grooved, rigid).

C. Manufacturers of Ductile Iron Pipe Couplings, or Equal:

1. Gustin-Bacon, (Aeroquip Corp.).

2. Victaulic Style 31 (flexible or rigid grooving).

Note: Ductile iron pipe couplings shall be furnished with flush seal gaskets.

D. Manufacturers of Couplings for PVC Pipe, or Equal:

1. Gustin-Bacon, (Aeroquip Corp).

2. Victaulic Style 775.

Note: Couplings for PVC pipe shall be furnished with radius cut or standard roll grooved pipe ends.

2.6 SLEEVE-TYPE COUPLINGS

A. Construction: Sleeve-type couplings shall be provided where indicated, in accordance with ANSI/AWWA C219 - Standard for Bolted Sleeve-Type Couplings for Plain-End Pipe, and shall be of steel with steel bolts, without pipe stop, and be of sizes to fit the pipe and fittings indicated. The middle ring shall be not less than 1/4-inch in thickness and shall be either 5 or 7 inches long for sizes up to and including 30 inches and 10 inches long for sizes greater than 30 inches, for standard steel couplings, and 16 inches long for long-sleeve couplings. The followers shall be single-piece contoured mill sections welded and cold-expanded as required for the middle rings, and of sufficient strength to accommodate the number of bolts necessary to obtain adequate gasket pressures without excessive rolling. The shape of the follower shall be of such design as to provide positive confinement of the gasket. Bolts and nuts shall conform to the requirements of Section 05500 – Miscellaneous Metals. Buried sleeve-type couplings shall be epoxy-coated at the factory as indicated.

B. Pipe Preparation: The ends of the pipe where indicated, shall be prepared for flexible steel couplings. Plain ends for use with couplings shall be smooth and round for a distance of 12 inches from the ends of the pipe, with outside diameter not more than 1/64-inch smaller than the nominal outside diameter of the pipe. The middle ring shall be tested by cold-expanding a minimum of one percent beyond the yield point, to proof-test the weld to the strength of the parent metal. The weld of the middle ring shall be subjected to air test for porosity.

C. Gaskets: Gaskets for sleeve-type couplings shall be rubber-compound material that will not deteriorate from age or exposure to air under normal storage or use conditions. Gaskets for wastewater and sewerage applications shall be Buna "N," Grade 60, or equivalent suitable elastomer. The rubber in the gasket shall meet the following specifications:

1. Color: Jet Black.

2. Surface: Non-blooming.

3. Durometer Hardness: 74 ± 5.

4. Tensile Strength: 1,000 psi minimum.

5. Elongation: 175 percent minimum.

6. The gaskets shall be immune to attack by impurities normally found in water or wastewater. All gaskets shall meet the requirements of ASTM D2000 - Classification System for Rubber Products in Automotive Applications, AA709Z, meeting Suffix B13 Grade 3, except as noted above. All gaskets shall be compatible with the piping service and fluid utilized.

D. Insulating Couplings: Where insulating couplings are required, both ends of the coupling shall have a wedge-shaped gasket which assembles over a rubber sleeve of an insulating compound in order to obtain insulation of all coupling metal parts from the pipe.

E. Restrained Joints: All sleeve-type couplings on pressure lines shall be harnessed, unless thrust restraint is provided by other means. Harnesses shall be in accordance with the appropriate reference standard, or as indicated.

F. Sleeve Type Coupling Manufacturers, or Equal:

1. Dresser, Style 38.

2. Smith-Blair, Style 411.

2.7 FLANGE COUPLING ADAPTERS

A. Flange adapters shall be fabricated from high strength steel. Flanges shall be supplied to AWWA C207, as well as all ANSI standards. Compression ends shall have wedge gasket for efficient sealing. Gasket material shall be suitable for raw wastewater. All miscellaneous metalwork items shall be Type 316 stainless steel.

B. Pipe ends shall be properly prepared for accepting the flange adapter in accordance with manufacturer's recommendations. The outside diameter and pipe type shall be verified prior to ordering adapters. Flange adapters shall be lined and coated with fusion bonded epoxy as specified in Section 09900 – Painting and Coatings.

C. Where cement mortar coated pipe is to be provided with sleeve type couplings, cement mortar coatings shall be heldback for coupling. Pipe shall be epoxy coated at location of coupling and cement mortar coating intersection.

D. Flange Adapters Shall Be Manufactured By, or Equal:

1. Dresser; Style 128.

2. Smith-Blair.

2.8 FLEXIBLE CONNECTORS

A. Flexible connectors shall be installed in all piping connections to engines, blowers, compressors, and other vibrating equipment, and where indicated. Flexible connectors for service temperatures up to 180 degrees F shall be flanged, reinforced Neoprene or

Butyl spools, rated for a working pressure of 40 to 150 psi, or reinforced, flanged duck and rubber, as best suited for the application. Flexible connectors for service temperatures above 180 degrees F shall be flanged, braided stainless steel spools with inner, annular, corrugated stainless steel hose, rated for minimum 150 psi working pressure, unless otherwise indicated. The connectors shall be a minimum of 9 inches long, face-to-face flanges, unless otherwise indicated. The final material selection shall be approved by the manufacturer. The Contractor shall submit manufacturer's shop drawings and calculations.

2.9 EXPANSION JOINTS

A. All piping subject to expansion and contraction shall be provided with sufficient means to compensate for such movement without exertion of undue forces to equipment or structures. This may be accomplished with expansion loops, bellow-type expansion joints, or sliding-type expansion joints. Expansion joints shall be of stainless steel, monel, rubber, or other materials, best suited for each individual service. The Contractor shall submit detailed calculations and manufacturer's shop drawings of all proposed expansion joints, piping layouts, and anchors and guides, including information on materials, temperature and pressure ratings.

B. For aeration air pipe provide metal expansion joint with non-controlled, hyroformed, high-corrugation stainless steel bellows. Shall be suitable for a maximum operating pressure of 50 psi as required by the system, and a temperature rating of 300 degrees F. Joints shall have a expansion/compression of plus/minus 3" or as required by the system, and have ANSI class 150 flanges, or grooved.

C. Sliding-type expansion joints shall have flanged ends and limit rods.

2.10 RUBBER FLEXIBLE CONNECTORS (FABRIC REINFORCED)

A. Flexible connectors shall be provided on the suction and discharge side of each pump, except sump pumps, and where shown on the Drawings. Where shown, flexible connectors shall be reducing, and/or eccentric.

B. Flexible connectors shall be fabric reinforced neoprene with 125-pound flanged ANSI end connections rated for 100 psi cold water service. The connectors shall have filled arches specifically for wastewater service. The connectors shall provide a minimum of 1/4-inch axial compression, 1/8-inch extension, 1/4-inch lateral deflection, and 2 degrees angular flexibility. All units shall be suitable for vibration and connection to pumping units. Units shall be manufactured by, or approved equal:

1. Holz Rubber Company, Inc.

2. Garlock.

3. Red Valve Company, Inc. – Redflex.

C. Each flexible connector shall be furnished and installed with harness bolt control units to prevent joint separation due to hydraulic pressure. Number and size of Type 316 stainless steel harness bolts shall be as necessary to withstand test pressures plus 50 psi surge. The internal materials of the flexible connectors shall be resistant to wastewater. Flexible connector to be used outdoors shall have a cover coating to

provide extra product protection against ultra-violet radiation, ozone, weather, and the environment, and shall be suitable for outdoor use.

2.11 PIPE THREADS

A. All pipe threads shall be in accordance with ANSI/ASME B1.20.1 - Pipe Threads, General Purpose (inch), made up with Teflon tape, unless otherwise indicated.

2.12 PIPE INSULATION

A. Hot and cold liquid piping, flues, and engine exhaust piping shall be insulated as shown, in accordance with the requirements indicated. No unprotected hot piping shall be within reach of operating personnel or other persons.

2.13 AIR AND GAS TRAPS

A. Air and gas pipes shall be sloping to low points, provided with drip legs, shut-off valves, strainers and traps. The traps shall be piped to the nearest drain. Air and gas traps shall be not less than 150-lb iron body float type with copper or stainless steel float. Bracket, lever, and pins shall be of stainless steel. Drain traps shall have threaded connections.

B. Manufacturers, or Equal:

1. Armstrong International, Inc.

2. Spirax Sarco, Inc.

2.14 GLASS LINING

A. General: Ductile iron or steel pipe and fittings shall be glass-lined where indicated. The glass lining shall be suitable for handling sewage, primary sludge, digested sludge, and scum. It shall be smooth, continuous, and suitable for prevention of grease and foam build-up. The glass lining shall be capable of withstanding thermal shock of 350 degrees F (430 degrees to 80 degrees) without crazing, blistering, or spalling.

B. Criteria: The glass lining shall consist of a vitreous material to meet or exceed the following criteria:

1. Unaffected by scraping with a sharp knife, simulating the effects of rodding.

2. Unaffected by the continuous application of live steam from a steam generator, immediately followed by a cold water quench.

3. Unaffected by an 8 percent sulfuric acid solution at 148 degrees F for a 10-minute period.

4. Minimum Thickness: 10 mils by micro test.

5. Spark Tested: The interior surfaces of the glass line pipe and fittings shall have continuous coverage, as verified with a low voltage wet sponge holiday detector per NACE RP0188-99, ASTM D5162, and SSPC Coating Manual. Pipe and fittings with holidays representing more than 0.01 percent of the total glassed

surface shall be rejected. Test procedure and acceptance criteria shall be per MP-92, Porcelain Enamel Continuity Testing, and documentation shall be furnished with each shipment of material listing the test results by identifying mark.

6. Hardness: 5-6 Mohs.

7. Density: 2.5-3.0 g/cu cm, measured by ASTM D792 - Test Method for Specific Gravity (Relative Density) and Density of Plastics by Displacement.

C. Application: Cast or ductile iron pipes and fittings shall be bored or machined smooth to remove voids or protrusions. Steel pipe shall be seamless pipe, with all internal fitting welds ground smooth, slag holes ground out, re-welded, and ground smooth. All interior surfaces shall be grit blasted to white metal and lining shall be fused on to chemically clean metal at above 1,400 degrees F. All welded flanges shall be factory-installed before lining. Screwed flanges or cast and ductile iron pipes shall be installed after lining. All pieces shall be sealed and tested prior to shipment. Finish shall be subject to the Engineer's approval.

D. Manufacturers, or Equal:

1. The Pfaudler Co, Inc., Rochester, New York.

2. A. O. Smith Corp., Florence, Kentucky.

3. Waterworks Mfg. Co., Marysville, California.

PART 3 EXECUTION

3.1 MATERIAL DELIVERY, STORAGE, AND PROTECTION

A. All piping materials, fittings, valves, and accessories shall be delivered in a clean and undamaged condition and stored off the ground for protection against oxidation caused by ground contact. All defective or damaged materials shall be replaced with new materials.

3.2 INSTALLATION

A. General:

1. All pipes, fittings, and appurtenances shall be installed in accordance with the requirements of the applicable Sections of Divisions 2 and 15.

2. Each pipe and fitting shall be carefully inspected before the exposed pipe or fitting is installed or the buried pipe or fitting is lowered into the trench. The laying of all pipe shall be in finished trenches free from water or debris. The lining and protective coating shall be inspected, and all damaged areas patched in the field with material similar to the original. Clean ends of pipe thoroughly. Remove foreign matter and dirt from inside of pipe and keep clean during and after laying.

3. Clean out fittings, valves, and pipe sections before installing.

4. Furnish and assemble pipe and fittings to provide accurate alignment for joints.

5. Make all joints watertight.

6. Use an anti-seize compound on all bolt threads. Manufacturer's instruction for application shall be followed. The anti-seize compound shall be designed to prevent rusting and seizure of bolt threads and to prevent galling of stainless steel.

7. Provide temporary plugs or bulkheads for closure of the open ends of piping whenever work is stopped.

8. Use proper implements, tools, and facilities for the safe and proper protection of the pipe. Carefully handle pipe in such a manner as to avoid any physical damage to the pipe. Do not drop or dump pipe into trenches under any circumstances.

9. In laying pressure pipelines, the deflection in a standard joint shall not exceed the manufacturer's recommendation. Deflections of more than 5 degrees shall require special bends or fittings. Departure from and return to established alignment and grade shall not exceed 1/16-inch per linear foot of pipe, and at no point shall the maximum departure from established line and grade be greater than 1-inch.

10. Each section of pipe shall be lowered into the trench, utilizing a sling or other device, in a manner that shall prevent injury to the pipe, coating, lining, or joints. In placing pipe in the trench, the pipe shall be held by the lowering device at the balancing point of the section. It shall not be dragged on the bottom of the trench, but shall be supported while being fitted into the adjacent section. Supporting the pipe on blocks, or blocking of any nature, either temporary or otherwise, will not be allowed.

11. It is the responsibility of the Contractor, when the pipeline and appurtenances are finally laid, to see that all joints are protected and that any damage to the coating or lining of the pipe and fittings has been adequately repaired or replaced in order to preserve their integrity for corrosion protection.

12. Repairs of defects that are discovered as a result of inspection or tests shall be made with new materials. Caulking of screwed joints, cracks, or holes will not be accepted. Tests shall be repeated after defects have been eliminated.

13. After completion of the work, all remaining pipe cuttings, joining and wrapping materials, and other scattered debris, shall be removed from the site. The entire piping system shall be handed over in a clean and functional condition.

14. Following assembly and testing, but prior to final acceptance, all pipelines shall be flushed with high velocity water or flushed with a cleaning ball. All accumulated construction debris and other foreign matter shall be removed. Flushing velocities shall be a minimum of 2.5 feet per second. Accumulated debris shall be removed through drains 2 inches and larger or by dropping spools and valves.

15. The Piping Schedule lists the pressures at which all lines shall be tested.

B. Exposed Pipe:

1. Where not detailed, exposed pipe shall be installed in straight runs parallel to the axes of the structures. Pipe runs shall be horizontal and vertical, except that

gravity lines shall have a minimum slope of not less than 0.5 percent, unless otherwise specified.

2. No exposed piping shall be erected until all equipment to which the pipe is to be attached has been installed and it can be determined where piping and fittings shall be located to make a neat, efficient arrangement.

3. The Contract Documents shall be taken as diagrammatic for piping that is not shown in detail. Sizes of piping and their locations are indicated, but it is not intended to show every offset and fitting nor every structural difficulty that will be encountered during the installation of the Work.

4. The alignment of pipes shall be varied from that indicated on the Contract Documents, without extra expense to the Owner where necessary to avoid structural or mechanical difficulties or to avoid the work of any other trades. The Contractor shall furnish such parts and pieces as may be necessary to provide a complete and operable system.

5. Pipe work shall be suspended and supported in such manner as to prevent sagging or overstressing of pipe and connections and, furthermore, shall be supported so that no item of the piping system will transfer any load or stress to any equipment.

6. Pipe and fittings shall be assembled so there will be no distortion or springing of the pipelines. Flanges, unions, flexible couplings, and other connections shall come together at the proper orientation. The fit shall not be made by springing any piping, nor shall orientation alignment be corrected by taking up on any flange bolts. Flange bolts, union halves, flexible connectors, etc. shall slip freely into place. If the proper fit is not obtained, the piping shall be altered to fit.

7. Piping shall be made up with a sufficient number of unions or flanged joints to permit ready breaking of lines as necessary for inspection and maintenance, in addition to such joints as are definitely shown on the Drawings.

3.3 TESTING

A. All piping shall be tested in accordance with the requirements of Section 02640 – Pipeline Testing and Disinfection.

END OF SECTION

SECTION 15005 – PIPING IDENTIFICATION SYSTEMS

PART 1 GENERAL

1.1 THE REQUIREMENT

A. The Contractor shall furnish, mark, and install identification devices for all exposed piping and valves using color bands, lettering, flow direction arrows, and related permanent identification devices, and all appurtenant works, in accordance with the requirements of the Contract Documents.

1.2 REFERENCE SPECIFICATIONS, CODES, AND STANDARDS

A. Commercial Standards:

ASME A13.1 Scheme for the Identification of Piping Systems.

NFPA 99 (National Fire Protection Association)

1.3 CONTRACTOR SUBMITTALS

A. Product Data: Submit manufacturer's catalog literature for each product required.

B. Samples: The Contractor shall submit samples of all types of identification devices to be used in the work to the Engineer, for approval prior to fabrication.

C. Submit list of wording, symbols, letter size, and color coding for mechanical identification and valve chart and schedule, including valve tag number, location, function, and valve manufacturer's name and model number prior to fabrication.

D. All submittals shall be in strict accordance with the requirements of Section 01340 - Shop Drawings, Product Data and Samples

E. Project Record Documents: Record actual locations of tagged valves; include valve tag numbers.

PART 2 PRODUCTS

2.1 IDENTIFICATION OF PIPING

A. Identification of all exposed pipe shall be accomplished by color-coding with bands and by lettering as specified in Part 3, herein, and in Section 09900 – Paint and Coatings. Color bands shall either be painted directly upon the pipe or shall be pressure-sensitive adhesive-backed vinyl cloth or plastic tape. Adhesive shall be recommended by the manufacturer for application to the specified coating systems.

B. Each pipe identification shall consist of 2 color-coded bands, a printed label identifying the name of the pipe, and a flow arrow to indicate direction of flow in the pipe. All labels shall be preprinted on pressure-sensitive adhesive-backed vinyl cloth or plastic tape. Arrows shall be die-cut of the same type of material as the labels.

C. Letter sizes and colors for lettering, arrows, and background shall conform to ASME A13.1.

D. Preprinted identification devices shall be as manufactured by:

1. W. H. Brady Co.

2. Seton Nameplate Corp., or equal.

E. Stencils

1. Manufacturers:

   a. Craftmark Identification Systems
   b. Safety Sign CO
   c. Seton Identification Products
   d. Substitutions: In accordance with Division 1 Requirements.

2. Stencils: With clean cut symbols and letters of following size:

   a. Up to 2 inches Outside Diameter of Insulation or Pipe: ½-inch-high letters
   b. 2½ to 6 inches (64-150 mm) Outside Diameter of Insulation or Pipe: 1-inch-high letters.

3. Stencil Paint: Semi-gloss enamel, colors and lettering size conforming to ASME A13.1.

2.2 EXISTING IDENTIFICATION SYSTEMS

A. In installations where existing piping identification systems have been established, the Contractor shall continue to use the existing system. Where existing identification systems are incomplete, utilize the existing system as far as practical and supplement with the specified system. The objective is to fully identify all new piping, valves, and appurtenances to the level specified herein.

2.3 IDENTIFICATION OF VALVES AND SHORT PIPE LENGTHS

A. Identifying devices for valves and the sections of pipe that are too short to be identified with color bands, lettered labels, and arrows shall be identified with metal or plastic tags as specified herein.

B. Metal tags shall be of stainless steel with embossed lettering. Plastic tags shall be of solid black plastic laminate with white embossed letters. All tags shall be designed to be firmly attached to the valves or short pipes or to the structure immediately adjacent to such valves or short pipes. Tags shall have a minimum dimension of 1½ inches.

C. Factory-fabricated, flexible, semi-rigid vinyl, preformed to fit around pipe or pipe covering. Larger sizes may have maximum sheet size with spring fastener.

PART 3 EXECUTION

3.1 PREPARATION

A. Degrease and clean surfaces to receive adhesive for identification materials

3.2 INSTALLATION

A. All labels and identification tags shall be installed in accordance with the manufacturer's printed instructions, and shall be neat and uniform in appearance. All such tags or labels shall be readily visible from all normal working locations.

B. Install identifying devices after completion of coverings and painting.

C. Install plastic nameplates with corrosive-resistant mechanical fasteners or adhesive.

D. Install labels with sufficient adhesive for permanent adhesion, and seal with clear lacquer. For unfinished canvas covering, apply paint primer before applying labels.

E. Identify valves in main and branch piping with tags.

F. Tag automatic controls, instruments, and relays. Key to control schematic.

G. Identify piping, concealed or exposed, with vinyl pipe markers. Use tags on piping ¾-inch-diameter and smaller. Identify service, flow direction, and pressure. Install in clear view and align with axis of piping. Locate identification not to exceed 20 feet on straight runs, including risers and drops, adjacent to each valve and tee, at each side of penetration of structure or enclosure, and at each obstruction.

3.3 VALVE TAGS

A. Valve tags shall be permanently attached to the valve or structure by means of 2 stainless steel bolts or screws or stainless steel corrosion resistant chains. The wording on the valve tags shall describe the exact function of each valve, e.g., "HWR-BALANCING," "FA-THROTTLING", "3W-PUMP SHUT-OFF," etc. and the equipment tag number shall also be included on the tag.

3.4 PIPE IDENTIFICATION

A. Each pipe shall be identified at intervals of 20 feet, and at least one time in each room. Piping shall also be identified at a point approximately within 2 feet of all turns, ells, valves, and on the upstream side of all distribution fittings or branches. Sections of pipe that are too short to be identified with color bands, lettered labels, and directional arrows shall be tagged and identified similar to valves.

B. Pipe identification shall consist of 4 elements, i.e., 2 color bands, a lettered label, and a directional label. The bands shall be arranged so that the lettered label and the directional arrow are placed between the 2 bands.

3.5 IDENTIFICATION SCHEDULE

A. Application of identifying devices shall conform to the following color codes (See ASME A13.1 for additional information):

Fluid Abbreviation	**Function and Identification**	**Background Color**	**Letter Color**
A	AIR	Light Green	Black
AA	AERATION AIR	Blue	White
BP	BYPASS	(same as corresponding fluid)	
BW	BACKWASH	Dark Brown	White
CA	COMPRESSED AIR	Blue	White

Fluid Abbreviation	Function and Identification	Background Color	Letter Color
D	DRAIN AND VENT	Dark Brown	White
DC	DUST CONTROL	Yellow	Black
DEC	DECANT	Dark Brown	White
DWS	DEWATERED SLUDGE	Dark Brown	White
FA	FOUL AIR	White	Black
H	SODIUM HYPOCHLORITE	Orange	Black
FSP	FIRE PROTECTION SPRINKLER	Red	White
IA	INSTRUMENT AIR	Blue	White
IRR	LANDSCAPE IRRIGATION	Purple	White
ML	MIXED LIQUOR	Dark Brown	White
MLR	MIXED LIQUOR RECYCLE	Dark Brown	White
NIT	NITROGEN	White	Black
NG	NATURAL GAS	Yellow	Black
OF	OVERFLOW	(same as corresponding fluid)	
PD	PUMPED DRAIN	Dark Brown	White
PW	POTABLE WATER	Green	White
PCD	PUMPED CHEMICAL DRAIN	Dark Brown	White
RAS	RETURN ACTIVATED SLUDGE	Dark Brown	White
REW	RECLAIMED WATER	Purple	White
SCUM	SCUM	Dark Brown	White
SB	SODIUM BISULFITE	Yellow	Black
SD	STORM DRAIN	Grey	White
SE	SECONDARY EFFLUENT	Dark Brown	White
TFR	THERMAL FLUID RETURN	Yellow	Black
TFS	THERMAL FLUID SUPPLY	Yellow	Black
UW	UTILITY WATER	Purple	White
V	VENT	(same as corresponding fluid)	
WAS	WASTE ACTIVATED SLUDGE	Dark Brown	White

END OF SECTION

SECTION 15006 – PIPE SUPPORTS

PART 1 GENERAL

1.1 THE REQUIREMENT

A. The Contractor shall provide pipe supports, hangers, guides, and anchors, complete, in accordance with the Contract Documents. The pipe supports indicated on the Drawings generally reference standard details, which are representative of industry standards. Not all the supports required for a complete installation are shown, or specifically called out. The Contractor shall provide all the necessary supports required for all the loads imposed on the piping system, including gravity, seismic, thermal, and pressure. The support systems shall include lateral bracing for seismic loads, and anchor bracing for thermal expansion/contraction.

1.2 REFERENCE SPECIFICATIONS, CODES, AND STANDARDS

AISC
ASTM A123
ANSI/ASME B31.1

1.3 CONTRACTOR SUBMITTALS

A. General: Submittals shall be in accordance with Section 01340 – Shop Drawings, Product Data and Samples.

B. Shop Drawings: Shop drawings shall be stamped by a licensed engineer to certify that supports have been designed per applicable codes, loads, and requirements and include the following information:

1. Drawings of pipe supports, hangers, anchors, and guides.
2. Calculations for special supports and anchors. Signed calculations shall be provided upon request.
3. Catalog Cut Sheets: Submit manufacturers catalog data including load capacity.

1.4 QUALITY ASSURANCE

A. Pipe hangers and supports shall be fabricated and installed by experienced welders and fitters, using the best welding procedures available. Fabricated supports shall be neat in appearance without sharp corners, burrs, and edges.

PART 2 PRODUCTS

2.1 GENERAL REQUIREMENTS

A. Code Compliance: All piping systems and pipe connections to equipment shall be properly anchored and supported to prevent undue deflection, vibration, dislocation due to seismic events and line pressures, and stresses on piping, equipment, and structures. All supports and parts thereof shall conform to the requirements of ANSI/ASME B31.1 - Power Piping, except as supplemented or modified below. Supports for plumbing piping shall be in accordance with the latest edition of the applicable plumbing code or local administration requirements.

1. All pipe supports and restraints shall be designed to support their respective pipes under the maximum combination of peak loading conditions, including pipe weight, liquid weight, liquid movement, pressure forces, thermal expansion and contraction, vibrations and all probable externally applied forces, including but not limited to seismic forces, wind forces and forces applied during construction.
2. The Contractor shall note that the pipe support details in the Drawings need to work as a system to resist seismic and wind forces. The Contractor shall install lateral supports as needed to resist the seismic and wind forces given in Section 01612- Seismic Design Criteria and Section 01614 - Wind Design Criteria. For special supports not defined in the Contract documents, the Contractor shall submit design calculations, shall be submitted to the Engineer in accordance with Section 01340 – Shop Drawings, Product Data, and Samples.

B. Structural Members: Wherever possible, pipes shall be supported from structural members. Where it is necessary to frame structural members between existing members, such supplementary members shall be provided by the Contractor at no additional cost to the Owner. All supplementary members shall be in accordance with the requirements of the building code and the American Institute of Steel Construction and shall be acceptable to the Engineer.

C. Pipe Hangers: Pipe hangers shall be capable of supporting the pipe in all conditions of operation, allowing free expansion and contraction of the piping, and preventing excessive stress on equipment. All hangers shall have a means of vertical adjustment after erection. Hangers shall be designed to prevent becoming disengaged by any movement of the supported pipe. Hangers subject to shock, seismic disturbances, or thrust imposed by the actuation of safety valves, shall include hydraulic shock suppressors. All hanger rods shall be subject to tensile loading only.

D. Hangers Subject to Horizontal Movements: At hanger locations where lateral or axial movement is anticipated, suitable linkage shall be provided to permit such movement. Where horizontal pipe movement is greater than 1/2 inch, or where the hanger rod deflection from the vertical is greater than 4 degrees from the cold to the hot position of the pipe, the hanger rod and structural attachment shall be offset in such a manner that the rod is vertical in the hot position.

E. Spring-Type Hangers: Spring-type pipe hangers shall be provided for piping subject to vibration or vertical expansion and contraction, such as engine exhausts and similar piping. All spring-type hangers shall be sized to the manufacturer's printed recommendations and the loading conditions encountered. Variable spring supports shall be provided with means to limit misalignment, buckling, eccentric loading, or to prevent overstressing of the spring, and with means to indicate at all times the compression of the spring. Supports shall be capable of accommodating at least 4 times the maximum travel due to thermal expansion.

F. Thermal Expansion: Wherever expansion and contraction of piping is expected, a sufficient number of expansion loops or joints shall be provided, together with the necessary rolling or sliding supports, anchors, guides, pivots, and restraints permitting the piping to expand and contract freely in directions away from the anchored points. All components shall be structurally suitable to withstand all loads imposed.

G. Heat Transmission: Supports, hangers, anchors, and guides shall be so designed and insulated, that excessive heat will not be transmitted to the structure or to other equipment.

H. Riser Supports: Where practical, risers shall be supported on each floor with riser clamps and lugs, independent of the connected horizontal piping.

I. Freestanding Piping: Free-standing pipe connections to equipment such as chemical feeders and pumps shall be firmly attached to steel frames fabricated from angles, channels, or I-beams anchored to the structure. Exterior, free-standing overhead piping shall be supported on fabricated pipe stands consisting of pipe columns anchored to concrete footings, with horizontal, welded steel angles and U-bolts or clamps securing the pipes.

J. Point Loads: Any meters, valves, heavy equipment, and other point loads on PVC, FRP, and other plastic pipes, shall be supported on both sides, according to manufacturer's recommendations to avoid undue pipe stresses and failures. To avoid point loads, all supports on PVC, FRP, and other plastic piping shall be equipped with extra wide pipe saddles or galvanized steel shields.

K. Noise Reduction: To reduce transmission of noise in piping systems, all copper tubes in buildings and structures shall be wrapped with a 2-inch wide strip of rubber fabric or similar, suitable material at each pipe support, bracket, clip, or hanger.

L. Stock Parts: Where not specifically indicated, stock or production parts shall be utilized wherever possible. Such parts shall be locally available, new, of best commercial quality, designed and rated for the intended purpose.

M. Supports and connections in the Biosolids Dryer Building and the Blower/Maintenance Building shall be coordinated with the metal building system components that is being designed and erected per Specification Section 13340.

2.2 MATERIALS OF CONSTRUCTION:

A. General: All pipe support assemblies, including framing, hardware, and anchors, shall be steel construction, galvanized after fabrication, unless otherwise indicated.

B. Submerged Supports: All submerged piping, as well as piping, conduits, and equipment in hydraulic structures below the top of the wall or within 36 inches of the water level, shall be supported with assemblies, including framing, hardware, and anchors, constructed of Type 316 stainless steel, unless otherwise indicated. Reference to standard details with carbon steel elements shall be constructed of stainless steel for these conditions.

C. Corrosive: All piping in chemical and corrosive areas shall be supported with support assemblies, including framing, hardware, and anchors, constructed of Type 316 stainless steel or FRP, unless otherwise indicated.

2.3 SUPPORT SPACING

A. Supports for piping with the longitudinal axis in approximately a horizontal position shall be spaced to prevent excessive sag, bending, and shear stresses in the piping, with special consideration given where components such as flanges and valves impose concentrated loads. Pipe support spacing shall not exceed the maximum spans in the tables below. For temperatures other than ambient temperatures, or those listed, and for other piping materials or wall thicknesses, the pipe support spacings shall be modified in accordance with the pipe manufacturer's recommendations. Vertical

supports shall be provided to prevent the pipe from being overstressed from the combination of all loading effects.

1. Support Spacing for Steel Pipe:

Nominal Pipe Diameter (inches)	Maximum Span (feet)
1/2	6
3/4 and 1	8
1-1/4 to 2	10
3	12
4	14
6	17
8 and 10	19
12 and 14	23
16 and 18	25
20 and Greater	30

2. Support Spacing for Welded Fabricated Steel Pipe:
   a. Maximum Spans for Pipe Supported in Minimum:
      1) 120 degree Contact Saddles (feet).

Nominal Pipe Diameter (inches)	Wall Thickness (inches)									
	3/16	1/4	5/16	3/8	7/16	1/2	5/8	3/4	7/8	1
24	33	37	41	43	45	47				
26	34	38	41	44	46	48				
28	34	38	41	44	47	49				
30	34	38	42	45	48	49				
32	34	39	42	45	48	50				
34	35	39	43	46	48	50				
36	35	39	43	46	49	51	55			
38	35	39	43	46	49	51	55			
40	35	40	43	47	49	52	56			
42	35	40	44	47	50	52	56			

3. For steel pipe sizes not presented in this table, the support spacing shall be designed so that the stress on the pipe does not exceed 5,000 psi. Maximum deflection of pipe shall be limited to 1/360th of the span and shall be calculated by using the formula:

$$L = \sqrt{\frac{7500tD}{32t + D}}$$

where:

t = Thickness (inches)
D = Diameter (inches)

L = Maximum span (feet)

4. Support Spacing for Ductile-Iron Pipe:

Nominal Pipe Diameter (inches)	Maximum Span (feet)
All Diameters	Two supports per pipe length or 10 feet (one of the 2 supports located at joint)

5. Support Spacing for Copper Tubing:

Nominal Pipe Diameter (inches)	Maximum Span (feet)
1/2 to 1-1/2	6
2 to 4	10
6 and Greater	12

6. Support Spacing for Schedule 80 PVC Pipe:

Nominal Pipe Diameter (inches)	Maximum Span at 100 degrees F (feet)
1/2	4
3/4	4.5
1	5
1-1/4	5.5
1-1/2	5.75
2	6.25
3	7.5
4	8.25
6	10
8	11
10	12.25
12	13.25

7. Support Spacing for Schedule 80 Polypropylene Pipe:

Nominal Pipe Diameter (inches)	Maximum Span at 100 degrees F (feet)
1/2	3
3/4	3.5
1	3.75
1-1/4	4
1-1/2	4.25
2	4.5
3	5.5
4	6
6	7.25
8	8
10	8.75

Nominal Pipe Diameter (inches)	Maximum Span at 100 degrees F (feet)
12	9.5

8. Support Spacing for Fiberglass Reinforced Plastic (FRP) Pipe:

Nominal Pipe Diameter (inches)	Maximum Span at 100 degrees F (feet)
2	8.8
3	10
4	11
6	12.7
8	13.4
10	14
12	15.4
14	16.2
16	17.3
18 and Greater	18

2.4 PROTECTIVE COATING

A. Galvanizing: Unless otherwise indicated, all fabricated pipe supports other than stainless steel or non-ferrous supports shall be blast-cleaned after fabrication and hot-dip galvanized in accordance with ASTM A123 - Specifications for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products.

B. Other Coatings: Other than stainless steel or non-ferrous supports, all supports shall receive protective coatings in accordance with the requirements of Section 09900 – Painting and Coatings.

2.5 MANUFACTURERS, OR EQUAL

1. Basic Engineers Inc., Pittsburgh, PA.

2. Bergen-Paterson Pipesupport Corp., Woburn, MA.

3. Grinnell Corp. (Supply Sales Company), Cranston, RI.

4. NPS Products, Inc., Westborough, MA.

5. Power Piping Company, Pittsburgh, PA.

6. Tolco Pipe Supports

PART 1 EXECUTION

3.1 DELIVERY AND STORAGE

A. The CONTRACTOR shall prepare and load all material and articles for shipment in a manner that protects the parts and coatings from damage in transit, shall include a packing list, and shall be responsible for and make good on any and all damage.

3.2 INSTALLATION

A. General: All pipe supports, hangers, brackets, anchors, guides, and inserts shall be fabricated and installed in accordance with the manufacturer's printed instructions and ANSI/ASME B31.1 - Power Piping. All concrete inserts for pipe hangers and supports shall be coordinated with the formwork.

B. Appearance: Pipe supports and hangers shall be positioned to produce an orderly, neat piping system. All hanger rods shall be vertical, without offsets. Hangers shall be adjusted to line up groups of pipes at the proper grade for drainage and venting, as close to ceilings or roofs as possible, without interference with other work.

C. Provide clearance in hangers and from structure and other equipment for installation of insulation.

END OF SECTION

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SECTION 15025 - STEEL PIPE (ASTM A53/A106, MODIFIED)

PART 1 GENERAL

1.1 THE REQUIREMENT

A. The Contractor shall furnish and install all steel pipe and all appurtenant work, complete and in place, including connection to existing and new structures in accordance with the requirements of the Contract Documents.

B. All pipe specified under this Section shall conform to the requirements of Section 15000 – Piping, General.

1.2 REFERENCE SPECIFICATIONS, CODES, AND STANDARDS

ANSI/ASME B16.3	Malleable Iron Threaded Fittings, Classes 150 and 300
ANSI/ASME B16.4	Cast Iron Threaded Fittings, Class 125 and 250
ANSI B16.5	Pipe Flanges and Flanged Fittings, Steel Nickel Alloy and Other Special Alloys
ANSI B16.11	Forged Steel Fittings, Socket-Welding and Threaded
ANSI B16.21	Nonmetallic Flat Gaskets for Pipe Flanges
ANSI/NFPA 70	National Electric Code
ASTM A53	Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated Welded and Seamless
ASTM A105	Specification for Forgings, Carbon Steel, for Piping Components
ASTM A106	Manual M11, C200, C208

1.3 CONTRACTOR SUBMITTALS

A. For the materials and equipment items supplied under the provisions of this Section, the Contractor shall submit copies of the manufacturer's product specifications and performance details according to the requirements of Section 01340 – Shop Drawings, Product Data and Samples.

B. Shop Drawings: The contractor shall submit detailed pipe fabrication drawings showing pipe details, special fittings and bends, dimensions, coatings, and other pertinent information. Layout drawings shall also be submitted showing location of each pipe section and each special length. Each pipe shall be numbered in installation sequence and the pipe pressure class shall be indicated

C. Manufacturer's written Quality Assurance/Control Program.

D. Certifications: The Contractor shall furnish a certified affidavit of compliance for all pipe and other products or materials furnished under this Section of the Specifications, as specified in the referenced standards.

1.4 QUALITY ASSURANCE

A. Inspection: All pipe shall be subject to inspection at the place of manufacture in accordance with the requirements of the applicable referenced standards as supplemented by the requirements herein. The Contractor shall notify the Engineer in writing of the manufacturing starting date not less than 14 calendar days prior to the start of any phase of the pipe manufacture.

B. During the manufacture of the pipe, the Engineer shall be given access to all areas where manufacturing is in process and shall be permitted to make all inspections necessary to confirm compliance with the Specifications

C. Tests: Unless otherwise specified, all material used in the manufacture of the pipe shall be tested in accordance with the requirements of the applicable referenced standards.

D. The Contractor shall perform all material tests at no additional costs to the Owner. The Engineer shall have the right to witness all testing conducted by the Contractor provided that the Contractor's schedule is not delayed for the convenience of the Engineer. In addition to those tests specifically required, the Engineer may request additional samples of any material for testing by the Owner. The additional samples shall be furnished at no additional cost to the Owner.

PART 2 PRODUCTS

2.1 GENERAL

A. The manufacturer shall legibly mark all pipes and specials in accordance with the laying schedule and marking diagram. Each pipe shall be numbered in sequence and said number shall appear on the laying schedule and marking diagram in its proper location for installation. All pipe sections and fittings shall be marked at each end with top field centerline.

2.2 PIPE MATERIAL

A. Pipe for water and wastewater process fluids 3 inches and diameter and above shall be mortar lined black steel pipe with flanged or grooved couplings joints. All pipe shall conform to ASTM A53 - Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated Welded and Seamless, or AWWA C200. All pipe 12 inches in diameter and less shall be Schedule 40, all pipe greater than 12 inches in diameter shall have a minimum wall thickness of 1/4 inch, unless otherwise required by Division 2 for the design pressures.

B. For Air, Nitrogen Gas, Fuel Gas, and Oil Service: Unless otherwise indicated, galvanized and black steel pipe shall conform to ASTM A53 - Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated Welded and Seamless or ASTM A106 - Specification for Seamless Carbon Steel Pipe for High Temperature Service, Grade B, and shall be Schedule 40, as indicated in the Piping Schedule. Galvanized steel pipe shall not be cement mortar lined unless so indicated.

C. Piping for the dewatered sludge system shall be ASTM A106, Grade B, Seamless. Piping system shall be a minimum Schedule 80.

D. Piping for the thermal fluid oil system 2 inches and smaller shall be ASTM A53, Type S, standard weight, Grade B; or ASTM A106, of equivalent thickness, socket welded with plain ends. Piping 2-1/2 inches and larger shall be ASTM A53, Type S, standard weight, Grade B, buttwelded with bevel ends. Pipe for thermal fluid oil service shall comply with ASME B31.

2.3 PIPE JOINTS

A. Black steel pipe for general service below 3 inches in diameter shall have screwed ends with NPT threads, welded joints, or flanged joints. Screwed joints shall be made up with Teflon tape and welded joints may have butt-weld fittings, or socket-weld fittings.

B. For all pipe 3 inches and above, black steel pipe shall have flanged ends, grooved ends for shouldered couplings or plain ends for sleeve-type couplings. Field welding of joints shall not be allowed unless there is an acceptable method of mortar lining repair.

C. Black steel pipe for chlorine or sulfur dioxide pressure service shall be socket-welded except where required to match mating fittings of vacuum regulator-check units, gas filters, valves, diaphragm units, gauges, and switches.

D. Galvanized steel pipe shall have screwed ends with NPT threads made up with Teflon tape. Where indicated, galvanized steel pipe shall have grooved ends for shouldered couplings or plain ends for sleeve-type couplings.

E. Where pressure conditions permit, black and galvanized steel pipe may have push-on joints for compression type fittings. For high pressure service these joints shall be harnessed.

F. Flanged joints are required for dewatered sludge piping at all valves and lubrication spool assemblies and as shown on the Drawings.

2.4 FITTINGS

A. Common Use: The following fittings shall be provided for galvanized or black steel pipe, as indicated in the Piping Schedule:

1. Threaded malleable iron fittings conforming to ANSI/ASME B16.3 – Malleable-Iron Threaded Fittings, Classes 150 and 300.

2. Threaded cast iron fittings conforming to ANSI/ASME B16.4 - Cast Iron Threaded Fittings, Class 125 and 250.

3. Forged steel socket welded fittings conforming to ANSI/ASME B16.11 - Forged Fittings, Socket - Welding and Threaded.

4. Butt welding fittings conforming to ANSI/ASME B16.9 - Factory-Made Wrought Steel Butt Welding Fittings, Schedule 40 or 80, as indicated.

5. Threaded cast iron drainage fittings conforming to ANSI/ASME 16.12 - Cast Iron Threaded Drainage Fittings.

6. Flanged cast iron fittings conforming to ANSI/ASME B16.1 - Cast Iron Pipe Flanges and Flanged Fittings, Class 25, 125, 250 and 800.

7. Flanged steel fittings conforming to ANSI/ASME B16.5 - Pipe Flanges and Flanged Fittings, Steel Nickel Alloy and Other Special Alloys.

8. Grooved ductile iron fittings with grooving dimensions conforming to ANSI/AWWA C606 - Joints, Grooved and Shouldered Type.

9. Compression-type steel fittings with armored Buna S gaskets for plain end pipe.

B. Special Applications: Fittings for chlorine and sulfur dioxide under pressure shall be 3,000 lb forged steel socket welded fittings conforming to ASTM A105, Grade 2 - Specification for Forgings, Carbon Steel, for Piping Components, and 300 lb forged steel fittings conforming to ANSI/ASME B16.11, as indicated in the Piping Schedule.

C. Flanges for chlorine and sulfur dioxide pressure service shall conform to ASTM A105, ANSI/ASME B16.5, Class 300, with 1/16-inch raised face, with 1/16-inch high temperature, compressed, self-centering ring type gaskets conforming to ANSI/ASME B16.21 - Nonmetallic Flat Gaskets for Pipe Flanges. Unions shall be four bolt tongue and groove, ammonia type, suitable for chlorine and sulfur dioxide service, with female threads and lead gaskets.

D. High tensile alloy steel corrosion-resistant bolts and nuts shall be used with each set of flanged unions. Unions shall be rated for 500 lb CWP service pressure, reducing-type, straight-type or blind-type, as required for the installation. Blind unions shall be provided as cleanouts where indicated, and straight unions shall be provided adjacent to each threaded valve or piece of equipment.

E. Dewatered Sludge Pipe Fittings:

1. Fittings shall be ASTM A106 Carbon Steel. Piping system shall be a minimum Schedule 80.

2. Elbows shall be long-radius, five (5) times the pipe diameter of the pipeline, unless noted otherwise, with integral tangent lengths equal to the nominal pipe size. Only in the case of space restrictions will shorter radius elbows be considered. Elbows shall also be smooth radius; mitered elbows are not acceptable. Reducers shall be concentric pattern unless noted otherwise.

3. Flanges shall be ANSI B16.5, Class 300 weld neck flange, raised face for pipe and valve joints and full face for pipeline lubrication rings and spacers. Flange faces shall be flat and perpendicular to the pipe center line. Angular deflection (layback) of the flange faces shall not exceed the allowable set forth by the governing standards.

4. All flanges shall be refaced after welding to the pipe, if necessary to prevent distortion of connecting valve bodies from excessive flange bolt tightening and to prevent leakage at the joint. The pipe end and flange face shall be finish machined in a single operation. Pipe lengths and dimensions and drillings of flanges shall be coordinated with the lengths and flanges for valves and other equipment to be installed in the piping. All mating flanges shall have the same diameter and drilling and shall be suitable for the pressures to which they will be subjected.

5. Gaskets for flange bolting shall conform to ASNI/AWWA C207, bolt and nut type with bolt-stud and two nuts permitted for 1 inch and larger.

F. Thermal Fluid Oil Pipe Fittings:

1. Fittings for piping 2 inch and smaller shall confirm to ANSI B16.11, Class 3000.

2. Fittings for piping 2-1/2 inch and larger shall confirm to ANSI/ASME B16.9, standard weight.

3. Flanges shall be ANSI/ASME B16.5, Class 300, ring type joint.

4. For flat faced flanges, gaskets shall be non asbestos filler with neoprene or nitrile binder; dimensions to suit flange contact face; 1/16 inch minimum thickness for plain finished surfaces, 3/32 inch minimum thickness for serrated surfaces. For raised face flanges, gaskets shall be continuous stainless steel ribbon wound into a spiral with non asbestos filler between adjacent coils with a carbon steel gauge ring. Compressed gasket thickness shall be 0.095 inch ±0.005 inch.

2.5 PIPE LINING

A. Mortar lining shall be provided on all black steel pipe for all water and wastewater process fluids. The mortar lining shall be in accordance with Division 2.

2.6 PROTECTIVE COATINGS

A. The exterior surfaces of pipe which will be exposed to the atmosphere inside structures or above ground shall be thoroughly cleaned and then given a shop coat of primer compatible with the finish coating required by Section 09900 – Painting and Coatings.

2.7 MANUFACTURERS OR EQUAL

A. Ameron

B. Northwest

C. U.S. Pipe

PART 3 EXECUTION

3.1 DELIVERY AND STORAGE

A. Delivery and storage of steel pipe and appurtenances shall be in accordance with Section 15000 – Piping, General.

B. The pipe shall be handled as a minimum at the 1/3 points by use of wide slings, padded cradles, or other devices designed and constructed to prevent damage to the pipe coating/exterior. The use of chains, hooks, or other equipment which might injure the pipe coating/exterior will not be permitted. Stockpiled pipe shall be supported on sand or earth berms free of rock exceeding 3 inches in diameter. The pipe shall not be rolled and shall be secured to prevent accidental rolling. All pipe handling equipment and methods shall be acceptable to the Engineer. The Contractor shall be fully liable for the cost of replacement or repair of pipe which is damaged.

3.2 INSTALLATION

A. General: All steel pipes shall be installed in a neat and workmanlike manner, properly aligned, and cut from measurements taken at the site, to avoid interferences with structural members, architectural features, openings, and equipment. Exposed pipes shall afford maximum headroom and access to equipment, and where necessary, all piping shall be installed with sufficient slopes for venting or drainage of liquids and condensate to low points. All installations shall be acceptable to the Engineer.

B. Pipe Preparation: Prior to installation, each pipe length shall be carefully inspected, be flushed clean of any debris or dust, and be straightened if not true. Ends of threaded pipes shall be reamed and filed smooth. All pipe fittings shall be equally cleaned before assemblage.

C. The Contractor shall inspect each pipe and fitting to insure that there are no damaged portions of the pipe. The Contractor shall remove or smooth out any burrs, gouges, weld splatter, or other small defects prior to laying the pipe.

D. Installation Tolerances: Each section of pipe shall be installed in the order and position shown on the laying diagram and in accordance with the following:

1. Each section of pipe having a nominal diameter less than 48 inches shall be installed to line and grade, within plus or minus 2 inches horizontal deviation and plus or minus 1-inch vertical deviation.

2. Each section of pipe having nominal diameter 48 inches and larger shall be installed to line and grade, within plus or minus 5 percent of diameter horizontal deviation and plus or minus 2.5 percent of diameter vertical deviation.

3. In addition to the horizontal and vertical tolerances above, install the pipe so that no high or low points other than those on the laying diagram are introduced.

E. Supports and Anchors: All piping shall be firmly supported with fabricated or commercial hangers or supports in accordance with Section 15006 - Pipe Supports. Where necessary to avoid stress on equipment or structural members, the pipes shall be anchored or harnessed. Expansion joints and guides shall compensate for pipe expansion due to temperature differences.

F. Valves and Unions: Water, steam, condensate, gas, vacuum, and air supply piping to fixtures, groups of fixtures, and equipment shall be provided with a shutoff valve and union, unless the valve has flanged ends. Low points in water systems and driplegs in steam, gas, and air systems shall have drainage valves. Unions shall be provided at threaded valves, equipment, and other devices requiring occasional removal or disconnection.

G. Branch Connections: Branch connections in horizontal runs of air and gas piping shall be made from the top of the pipe, to avoid drainage of condensate into the equipment.

H. Threaded Joints: Pipe threads shall conform to ANSI/ASME B1.20.1 - Pipe Threads, General Purpose (inch), and shall be full and cleanly cut with sharp dies. Not more than three threads shall remain exposed after installation.

I. Welded Joints: Welded joints shall conform to the specifications and recommendations of ANSI/ASME B31.1 - Power Piping. All welding shall be done by skilled and qualified welders per Section 15000 – Piping, General.

J. Grooved Joints: Grooves for grooved couplings and fittings shall be made with specially designed grooving tools to the Manufacturer's recommendations and conform to ANSI/AWWA C606. All grooves shall be clean and sharp without flaws, and the pipe ends shall be accurately cut at 90 degrees to the pipe axis.

K. Push-On Joints: Push on joints and gasket installation shall be in accordance with the manufacturer's recommendations and lubricants. Pipe ends shall be beveled to facilitate assembly. Lubricants shall be suitable for potable water service and shall be kept clean in closed containers.

3.3 TESTING

A. All finished installations shall be carefully inspected for proper supports, anchoring, interferences, and damage to pipe, fittings, and coating. Any damage shall be repaired to the satisfaction of the Engineer.

B. Field Testing: Prior to enclosure or burying, all piping systems shall be pressure tested as required in the Piping Schedule, for a period of not less than one hour, without exceeding the tolerances listed in the Process Fluid Pipe Schedule. Where no pressures are indicated, the pipes shall be subject to 1-1/2 times the maximum working pressure. The Contractor shall furnish all test equipment, labor, materials, and devices at no extra cost to the Owner. For additional testing requirements, refer to Section 02640 – Pipeline Testing and Disinfection.

1. Leakage may be determined by loss of pressure, soap solution, chemical indicator, or other positive and accurate method. All fixtures, devices, or other accessories which are to be connected to the lines and which would be damaged if subjected to the test pressure shall be disconnected and ends of the branch lines plugged or capped as required during the testing procedures.

2. Leaks shall be repaired to the satisfaction of the Engineer, and the system shall be retested until no leaks are found.

END OF SECTION

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SECTION 15030 – STAINLESS STEEL PIPE (ASTM A312, MODIFIED)

PART 1 GENERAL

1.1 THE REQUIREMENT

A. The Contractor shall furnish and install all stainless steel pipe and all appurtenant work, complete and in place, including connection to existing and new structures in accordance with the requirements of the Contract Documents.

B. All pipe specified under this Section shall conform to the requirements of Section 15000 – Piping, General.

1.2 REFERENCE SPECIFICATIONS, CODES, AND STANDARDS

A. All work shall be performed in strict conformance with the industry standards, local laws, and ordinance specified in the General Requirements. Wherever the requirements of the specifications exceed those of these codes, the requirements of the specifications shall govern. Code compliance is mandatory. Nothing in these Contract Documents shall be construed as permitting work not in accordance with these laws and codes.

B. Commercial Standards:

ANSI B16.1	Cast Iron Pipe Flanges and Flanged Fittings Classes 25, 125, 250, and 800
ANSI B16.11.80	Forged Steel Fitting, Socket Welded and Threaded
ANSI B31.1	Power Piping
ANSI B36.19M	Stainless Steel Pipe
ASME Section IX (1989)	Boiler and Pressure Vessel Code; Welding and Brazing Qualifications
ASTM A182/A182M	Forged or Rolled Alloy-Steel Pipe Flanges, Forged Fittings, and Valves and Parts for High-Temperature Service
ASTM A240	Heat-Resisting Chromium and Chromium Nickel Stainless Steel Plate, Sheet, and Strip for Pressure Vessels
ASTM A276	Stainless and Heat-Resisting Steel Bars and Shapes
ASTM A312/A312M	Seamless and Welded Austenitic Stainless Steel Pipe
ASTM A320/A320M	Alloy Steel Bolting Materials for Low-Temperature Service
ASTM A403/A403M	Wrought Austenitic Stainless Steel Piping Fitting

ASTM A409/A409M	Welded Large Diameter Austenitic Steel Pipe for Corrosive or High Temperature Service
ASTM A480/A480M	General Requirements for Flat-Rolled Stainless and Heat-Resisting Steel Plate, Sheet, and Strip
ASTM A774/A774M	As-Welded Wrought Austenitic Stainless Steel Fittings for General Corrosive Service at Low and Moderate Temperatures
ASTM A778	Welded, Unannealed Austenitic Stainless Steel Tubular Products

1.3 CONTRACTOR SUBMITTALS

A. For the materials and equipment items supplied under the provisions of this Section, the Contractor shall submit copies of the manufacturer's product specifications and performance details according to the requirements of Section 01340 – Shop Drawings, Product Data and Samples.

B. Shop Drawings: The contractor shall submit detailed pipe fabrication drawings showing pipe details, special fittings and bends, dimensions, coatings, and other pertinent information. Layout drawings shall also be submitted showing location of each pipe section and each special length. Each pipe shall be numbered in installation sequence and the pipe pressure class shall be indicated

C. Manufacturer's written Quality Assurance/Control Program.

D. Certifications: The Contractor shall furnish a certified affidavit of compliance for all pipe and other products or materials furnished under this Section of the Specifications, as specified in the referenced standards.

1.4 QUALITY ASSURANCE

A. Inspection: All pipe shall be subject to inspection at the place of manufacture in accordance with the requirements of the applicable referenced standards as supplemented by the requirements herein. The Contractor shall notify the Engineer in writing of the manufacturing starting date not less than 14 calendar days prior to the start of any phase of the pipe manufacture.

B. During the manufacture of the pipe, the Engineer shall be given access to all areas where manufacturing is in process and shall be permitted to make all inspections necessary to confirm compliance with the Specifications

C. Tests: Unless otherwise specified, all material used in the manufacture of the pipe shall be tested in accordance with the requirements of the applicable referenced standards.

D. The Contractor shall perform all material tests at no additional costs to the Owner. The Engineer shall have the right to witness all testing conducted by the Contractor provided that the Contractor’s schedule is not delayed for the convenience of the Engineer. In addition to those tests specifically required, the Engineer may request additional samples of any material for testing by the Owner. The additional samples shall be furnished at no additional cost to the Owner.

PART 2 PRODUCTS

2.1 PIPE MATERIAL

A. Unless otherwise indicated, stainless steel pipe shall be in accordance with ASTM A312 - Specification for Seamless and Welded Austenitic Stainless Steel Pipe, Type 316, seamless, Schedule 40, with screwed fittings for sizes up to and including 2-1/2 inches, and welding fittings or flanged fittings for sizes 3 inches and larger. Stainless steel pipe 12 inches in diameter and larger shall be in accordance with ASTM A409 - Specification for Welded Large Diameter Austenitic Steel Pipe for Corrosive or High-Temperature Service, or A778 - Specification for Welded, Unannealed Austenitic Stainless Steel Tubular Products, Type 316, of the schedules indicated, with welded or flanged joints.

2.2 STAINLESS STEEL TUBING

A. The Contractor shall furnish and install stainless steel tubing for instrument air 3/8-inch and smaller. Stainless steel tubing shall be of the size indicated on the drawings or, if not indicated, shall be sized to adequately perform the function intended. In no case shall tubing be less than 1/4-inch outside diameter.

B. Stainless steel tubing shall be used for all control or instrument air piping. Stainless steel tubing shall be seamless tubing made of Type 316 stainless steel and shall conform to ASTM A269. Wall thickness shall be adequate for test pressure specified, but shall not be less than 0.035 inch.

C. Fittings for use with stainless steel tubing shall be of the swage type (flare, bite, or compression types are not acceptable), and all components shall be made of Type 316 stainless steel. Fittings shall be of the two ferrule design, resulting in a primary seal and two secondary seals. Fittings shall be Crawford Fitting Company “Swagelok”, “Hoke Gyrolok”, or equal. Valves for use with stainless steel tubing shall be air cocks of Type 316 stainless steel.

2.3 PIPE JOINTS

A. Stainless steel pipe for sizes 2-1/2 inches and smaller shall have screwed ends with NPT threads made up with Teflon tape except for Nitrogen service piping. Stainless steel pipe 3 inches and larger and where indicated shall have welded joints with socket-welding fittings, butt-welding fittings, or socket welding flanges except for Nitrogen service piping. All stainless steel flanges shall have stainless steel bolts and nuts. Where indicated, stainless steel pipe shall have grooved ends for shouldered couplings, except that no pipe with less than Schedule 40 wall thickness shall be grooved. Where indicated, stainless steel pipe shall have plain ends for sleeve-type couplings. Nitrogen service stainless steel piping shall be socket-welded joints.

2.4 FITTINGS

A. Threaded Fittings: Forged stainless steel fittings conforming to ANSI/ASME B16.11 - Forged Fittings, Socket-Welding and Threaded, Type 316.

B. Socket-Welding Fittings: Forged stainless steel fittings conforming to ANSI/ASME B16.11, Type 316.

C. Butt-Welding Fittings: Wrought stainless steel butt-welding fittings conforming to ASTM A403 - Specification for Wrought Austenitic Stainless Steel Piping Fittings, and ANSI/ASME B16.9 - Factory-Made Wrought Steel Butt-Welding Fittings, Type 316.

D. Grooved Fittings: Wrought stainless steel grooved fittings conforming to ASTM A403 and ANSI/ASME B16.9, with grooving conforming to ANSI/AWWA C606 - Grooved and Shouldered Joints, Type 316.

E. Flanged Fittings: Type 316 stainless steel flanged fittings and flanges conforming to ANSI/ASME B16.5 - Pipe Flanges and Flanged Fittings.

F. Pressure Class: Unless otherwise indicated, all fittings shall be in accordance with the pressure classes called for in the Piping Schedule. Where not indicated, the fittings shall have the same pressure rating as the pipe.

2.5 COUPLINGS

A. Couplings and flange coupling adapters shall be of 304 stainless steel or fusion bonded epoxy coated steel. Gaskets shall be EPDM. Couplings and flange coupling adapter shall meet the requirements of Section 15000 Piping General.

PART 3 EXECUTION

3.1 DELIVERY AND STORAGE

A. Delivery and storage of steel pipe and appurtenances shall be in accordance with Section 15000 – Piping, General.

B. The pipe shall be handled as a minimum at the 1/3 points by use of wide slings, padded cradles, or other devices designed and constructed to prevent damage to the pipe coating/exterior. The use of chains, hooks, or other equipment which might injure the pipe coating/exterior will not be permitted. Stockpiled pipe shall be supported on sand or earth berms free of rock exceeding 3 inches in diameter. The pipe shall not be rolled and shall be secured to prevent accidental rolling. All pipe handling equipment and methods shall be acceptable to the Engineer. The Contractor shall be fully liable for the cost of replacement or repair of pipe which is damaged.

3.2 INSTALLATION

A. General: All stainless steel pipes shall be installed in a neat and workmanlike manner, properly aligned and cut from measurements taken at the site to avoid interferences with structural members, architectural features, openings, and equipment. Exposed pipes shall afford maximum headroom and access to equipment, and where necessary all piping shall be installed with sufficient slopes for venting or drainage of liquids and condensate to low points. All installations shall be acceptable to the Engineer.

B. Supports and Anchors: All piping shall be firmly supported with fabricated or commercial hangers or supports in accordance with Section 15006 – Pipe Supports. Where necessary to avoid stress on equipment or structural members, the pipes shall be anchored or harnessed. Expansion joints and guides shall compensate for pipe expansion due to temperature differences.

C. Valves and Unions: Unless otherwise indicated, all connections to fixtures, groups of fixtures, and equipment shall be provided with a shutoff valve and union, unless the

valve has flanged ends. Unions shall be provided at threaded valves, equipment, and other devices requiring occasional removal or disconnection.

3.3 PIPE PREPARATION

A. Prior to installation, each pipe length shall be carefully inspected, be flushed clean of any debris or dust, and be straightened if not true. Ends of threaded pipes shall be reamed and filed smooth. All pipe fittings shall be equally cleaned before assembly.

3.4 PIPE JOINTS

A. Threaded Joints: Pipe threads shall conform to ANSI/ASME B1.20.1 - Pipe Threads, General Purpose (inch), and shall be full and cleanly cut with sharp dies. Not more than three threads shall remain exposed after installation.

B. Welded Joints: Welded joints shall conform to the specifications and recommendations of ANSI/ASME B31.1 - Power Piping. All welding shall be done by skilled and qualified welders per Section 15000 – Piping, General.

1. Field welding shall be minimized to the greatest extent possible by use of couplings and prefabrication of pipe systems at the factory. Pipe butt welds may be performed at the job site, providing the butt welds are performed only with an inert gas shielded process and that other indicated welding requirements are followed rigidly.

2. All residue, oxide, and heat stain is to be removed from any type of field weld and the affected areas adjacent by the use of stainless steel wire brushes, followed by cleaning with an agent such as Eutectic Company's "Euclean" or equal, followed by complete removal of the agent.

C. Grooved Joints: Grooves for grooved couplings and fittings shall be made with specially designed grooving tools to the Manufacturer's recommendations and conforming to ANSI/AWWA C606. All grooves shall be clean and sharp without flaws, and the pipe ends shall be accurately cut at 90 degrees to the pipe axis.

3.5 INSPECTION AND FIELD TESTING

A. Inspection: All finished installations shall be carefully inspected for proper supports, anchoring, interferences, and damage to pipe, fittings, and coating. Damage shall be repaired to the satisfaction of the Engineer.

B. Field Testing: Prior to enclosure or burying, all piping systems shall be pressure tested as required in the Piping Schedule, for a period of not less than one hour, without exceeding the tolerances listed in the Piping Schedule. Where no pressures are indicated, the pipes shall be subject to 1-1/2 times the maximum working pressure. The Contractor shall furnish all test equipment, labor, materials, and devices at no extra cost to the Owner. For additional testing requirements refer to Section 02640 – Pipeline Testing and Disinfection.

1. Leakage may be determined by loss of pressure, soap solution, chemical indicator, or other positive and accurate method. All fixtures, devices, or other accessories which are to be connected to the lines and which would be damaged

if subjected to the test pressure shall be disconnected and ends of the branch lines plugged or capped as required during the testing procedures.

2. Leaks shall be repaired to the satisfaction of the Engineer and the system shall be re-tested until no leaks are found.

END OF SECTION

SECTION 15036 – COPPER PIPE

PART 1 GENERAL

1.1 THE REQUIREMENT

A. The Contractor shall furnish and install all copper pipe and all appurtenant work, complete and in place, including connection to existing and new structures in accordance with the requirements of the Contract Documents.

B. All pipe specified under this Section shall conform to the requirements of Section 15000 – Piping, General.

1.2 REFERENCE SPECIFICATIONS, CODES, AND STANDARDS

A. All work shall be performed in strict conformance with the industry standards, local laws, and ordinance specified in the General Requirements. Wherever the requirements of the specifications exceed those of these codes, the requirements of the specifications shall govern. Code compliance is mandatory. Nothing in these Contract Documents shall be construed as permitting work not in accordance with these laws and codes.

B. Commercial Standards: In case of conflict between the requirements of this Section and those of the listed requirements the more stringent requirement shall be conformed to. The latest edition of the following references at the time of bid shall be used.

ANSI B16.22	Wrought Copper and Copper Allot Solder Joint Pressure Fittings
ANSI B16.26	Cast Copper Alloy Fittings for Flared Copper Tubes
ASTM B32	Solder Metal
ASTM B75	Seamless Copper Tube
ASTM B88	Seamless Copper Water Tube
Uniform Building Code	

1.3 CONTRACTOR SUBMITTALS

A. For the materials and equipment items supplied under the provisions of this Section, the Contractor shall submit copies of the manufacturer's product specifications and performance details according to the requirements of Section 01340 -Shop Drawings, Product Data and Samples and the follow supplemental requirements:

1. List of pipe and fittings to be used
2. Manufacturer
3. Model Number
4. Size and Schedule
5. Material
6. Pressure Rating

7. Catalogue data
8. Drawings

B. Shop Drawings: The Contractor shall submit detailed pipe fabrication drawings showing pipe details, special fittings and bends, dimensions, coatings, and other pertinent information. Layout drawings shall also be submitted showing location of each pipe section and each special length. Each pipe shall be numbered in installation sequence and the pipe pressure class shall be indicated.

C. Manufacturer's written Quality Assurance/Control Program.

D. Certifications: The Contractor shall furnish a certified affidavit of compliance for all pipe and other products or materials furnished under this Section of the Specifications, as specified in the referenced standards.

1.4 QUALITY ASSURANCE

A. Inspection: All pipe shall be subject to inspection at the place of manufacture in accordance with the requirements of the applicable referenced standards as supplemented by the requirements herein. The Contractor shall notify the Engineer in writing of the manufacturing starting date not less than 14 calendar days prior to the start of any phase of the pipe manufacture.

B. During the manufacture of the pipe, the Engineer shall be given access to all areas where manufacturing is in process and shall be permitted to make all inspections necessary to confirm compliance with the Specifications

C. Tests: Unless otherwise specified, all material used in the manufacture of the pipe shall be tested in accordance with the requirements of the applicable referenced standards.

D. The Contractor shall perform all material tests at no additional costs to the Owner. The Engineer shall have the right to witness all testing conducted by the Contractor provided that the Contractor’s schedule is not delayed for the convenience of the Engineer. In addition to those tests specifically required, the Engineer may request additional samples of any material for testing by the Owner. The additional samples shall be furnished at no additional cost to the Owner.

PART 2 PRODUCTS

2.1 GENERAL

A. The manufacturer shall legibly mark all pipes and specials in accordance with the laying schedule and marking diagram. Each pipe shall be numbered in sequence and said number shall appear on the laying schedule and marking diagram in its proper location for installation. All pipe sections and fittings shall be marked at each end with top field centerline.

2.2 PIPE MATERIAL

A. Copper pipe shall be hard drawn and shall conform to the requirements of ASTM B42 - Specification for Seamless Copper Pipe, Standard Sizes, with regular or extra strong wall thickness, as indicated in the Piping Schedule.

B. Copper water tube shall conform to the requirements of ASTM B88 - Seamless Copper Water Tube, and shall be soft temper tube in rolls for buried locations, or hard drawn lengths for all other applications. Unless otherwise indicated, all copper water tube shall be of Type K wall thickness.

2.3 PIPE JOINTS

A. Copper water tube shall have either: soldered joints, flared ends and fittings, or compression type joints. Soldered joints shall be made with 95 – 5 percent tin-antimony solder or with silver solder. Buried piping shall have flared or compression type joints. No soft-soldered joints will be allowed on buried piping. No solders containing more than 0.2 percent of lead shall be used. Copper pipe shall have screwed ends for NPT fittings or brazed joints. Screwed joints shall be made up with Teflon tape. Brazed or screwed joints may be used in connection with flanges and flanged fittings.

2.4 FITTINGS

A. Threaded Fittings: Threaded cast bronze fittings for copper pipe shall be in accordance with ANSI/ASME B16.15 - Cast Bronze Threaded Fittings, Classes 125 and 250, as indicated in the Piping Schedule.

B. Flanged Fittings: Cast copper alloy flanges and flanged fittings shall be in accordance with ANSI/ASME B16.24 - Cast Copper Alloy Pipe Flanges and Flanged Fittings, and ASTM B62 - Composition Bronze or Ounce Metal Castings, with 150 lb rating, or as indicated.

C. Flared Fittings: Flared fittings shall conform to ANSI/ASME B16.26 - Cast Copper Alloy Fittings for Flared Copper Tubes.

D. Compression Fittings: Compression type fittings shall be brass fittings as manufactured by:

1. Crawford Company; SWAGELOK.
2. Parker-Hannifin; CPI.
3. Or equal.

2.5 PROTECTIVE COATING

A. The exterior surfaces of pipe which will be exposed to the atmosphere inside structures or above ground shall be thoroughly cleaned and then given a shop coat of primer compatible with the finish coating required by Section 09900 – Painting and Coatings.

PART 3 EXECUTION

3.1 DELIVERY AND STORAGE

A. Delivery and storage of steel pipe and appurtenances shall be in accordance with Section 15000 – Piping, General.

B. The pipe shall be handled as a minimum at the 1/3 points by use of wide slings, padded cradles, or other devices designed and constructed to prevent damage to the pipe coating/exterior. The use of chains, hooks, or other equipment which might injure the pipe coating/exterior will not be permitted. Stockpiled pipe shall be supported on sand or earth

berms free of rock exceeding 3 inches in diameter. The pipe shall not be rolled and shall be secured to prevent accidental rolling. All pipe handling equipment and methods shall be acceptable to the Engineer. The Contractor shall be fully liable for the cost of replacement or repair of pipe which is damaged.

3.2 INSTALLATION

A. General: All copper pipes shall be installed in a neat and workmanlike manner, properly aligned, and cut from measurements taken at the site to avoid interferences with structural members, architectural features, openings, and equipment. Exposed pipes shall afford maximum headroom and access to equipment, and where necessary, all piping shall be installed with sufficient slopes for venting or drainage of liquids and condensate to low points. All installations shall be acceptable to the Engineer.

B. Pipe Preparation: Prior to installation, each pipe length shall be carefully inspected, be flushed clean of any debris or dust, and be straightened if not true. Ends of threaded pipes shall be reamed and filed smooth. All pipe fittings shall be equally cleaned before assemblage.

C. The Contractor shall inspect each pipe and fitting to insure that there are no damaged portions of the pipe. The Contractor shall remove or smooth out any burrs, gouges, weld splatter, or other small defects prior to laying the pipe.

D. Supports and Anchors: All piping shall be firmly supported with fabricated or commercial hangers or supports in accordance with Section 15006 – Pipe Supports. Where necessary to avoid stress on equipment or structural members, the pipes shall be anchored or harnessed. Expansion joints and guides shall compensate for pipe expansion due to temperature differences. Supports shall be copper-plated steel to prevent galvanic corrosion.

E. Valves and Unions: Unless otherwise indicated, piping to fixtures, groups of fixtures, and equipment shall be provided with a shutoff valve and union, unless the valve has flanged ends. Low points in water systems and driplegs in steam, gas, and air systems shall have drainage valves. Unions shall be provided at threaded valves, equipment, and other devices requiring occasional removal or disconnection.

F. Branch Connections: Branch connections in horizontal runs of air and gas piping shall be made from the top of the pipe to avoid drainage of condensate into the equipment.

G. Copper tubing for hot water shall be provided with silver brazing with insulation.

3.3 SOLDERING

A. Solder Joints: All pipe and fittings to be jointed with solder shall be free from all burrs and wire brushed or steel wool cleaned. After cleaning, the flux shall be evenly and sparingly applied to the surfaces to be joined. Solder shall then be applied and the flame passed toward the center of the fitting until the solder disappears. All excess solder shall be removed while it is still plastic. Absolutely no acid flux or acid wipe shall be used in making solder joints. Joints shall not be quenched after soldering.

B. Solder used in copper piping shall be in accordance with ASTM B32, Grade 95 TA. Do not use cored solder.

3.4 PIPE JOINTS

A. Threaded Joints: Pipe threads shall conform to ANSI/ASME B1.20.1 - Pipe Threads, General Purpose (inch), and shall be full and cleanly cut with sharp dies and friction tools. Not more than three threads shall remain exposed after installation.

B. Brazed Joints: Brazed joints shall conform to the specifications and recommendations of ANSI/ASME B31.1 - Power Piping. All welding shall be done by skilled and qualified welders per Section 15000 – Piping, General.

3.5 INSPECTION AND FIELD TESTING

A. Inspection: All finished installations shall be carefully inspected for proper supports, anchoring, interferences, and damage to pipe, fittings, and coating. Damage shall be repaired to the satisfaction of the Engineer.

B. Field Testing: Prior to enclosure or burying, all piping systems shall be pressure tested as required in the Piping Schedule, for a period of not less than one hour, without exceeding the tolerances listed in the Piping Schedule. Where no pressures are indicated, the pipes shall be subject to 1-1/2 times the maximum working pressure. The Contractor shall furnish all test equipment, labor, materials, and devices at no extra cost to the Owner. For additional testing requirements, refer to Section 02640 – Pipeline Testing and Disinfection.

1. Leakage may be determined by loss of pressure, soap solution, chemical indicator, or other positive and accurate method. All fixtures, devices, or other accessories which are to be connected to the lines and which would be damaged if subjected to the test pressure shall be disconnected and ends of the branch lines be plugged or capped as required during the testing procedures.

2. Leaks shall be repaired to the satisfaction of the Engineer, and the system shall be retested until no leaks are found.

END OF SECTION

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SECTION 15050 - MECHANICAL GENERAL PROVISIONS

PART 1 PART 1 - GENERAL REQUIREMENTS

1.1 GENERAL CONDITIONS:

The general conditions and Division 1 are a part of this section and the contract for this work and apply to this section as fully as if repeated herein. This section, 15050, applies to Division 15 categories, including but not limited to:

Section 15500 Heating, Ventilating and Air Conditioning

A. Reference to Other Sections: The applicable requirements from the above sections shall form a part of the mechanical work and each section shall consult the other sections in detail for general and specific requirements.

1.2 SCOPE:

These Division 15 specifications and the accompanying drawings are intended to comprise the furnishing of all labor, and the furnishing and installing of all materials, equipment and supplies as specified herein and required for the satisfactory completion by the Contractor of all work pertaining to mechanical trades.

1.3 EXPLANATION OF DRAWINGS AND REFERENCE TO SCHEDULES:

A. The drawings and these specifications are complementary to each other in that all apparatus, materials and equipment outlined in the drawings and/or specified herein shall be considered essential to the contract.

B. The specifications are intended to describe the quality and character of the materials and equipment and methods of installation. All miscellaneous items of work and materials necessary for the completion of the installation shall be provided, whether or not mentioned in the specifications or shown on the drawings.

C. Space allotted, clearances, access, electrical data, structural supports, etc., on drawings, is for equipment models and sizes as listed in schedules on plans. The Contractor shall assume the responsibility for the coordination with other trades required in the use of equal or substitute equipment or materials and pay all difference in cost arising from such substitutions, regardless of approval.

D. Separate Sections cover the Site Work, Architectural Work and the Electrical Work. The Contractor shall familiarize themselves with the entire specification.

E. Should there be any question as to the scope of the work for which the Contractor is responsible, they shall ask the Architect for an interpretation before submitting their bid. In the event that the Contractor finds discrepancies or omissions, or is in doubt as to the exact meaning of the plans and/or specifications, they shall, before submitting bid, contact the Mechanical Engineer for clarification.

F. For purposes of clearness and legibility, drawings are essentially diagrammatic and, although size and location of equipment are drawn to scale wherever possible, the

Contractor shall make use of all data in all the contract documents and shall verify this information at building site.

G. The drawings indicate required size and points of termination of pipes, and suggest proper routes to conform to structure, avoid obstructions and preserve clearances. However, it is not intended that drawings indicate all necessary offsets, and it shall be the work of the Contractor to make the installation in such a manner as to conform to structure, avoid obstruction, preserve headroom and keep openings and passageways clear.

H. It is intended that all apparatus be located symmetrical with architectural elements. Refer to architectural details in completing the correlating work.

I. The Contractor shall fully inform themselves regarding any and all peculiarities and limitations of the spaces available for the installation of all work and materials furnished and installed under the contract. They shall exercise due and particular caution to determine that all parts of their work are made quickly and easily accessible.

J. The Contractor shall study all drawings and specifications to determine any conflict with ordinances and statutes. Any errors or omissions shall be reported, and any changes shall be shown in the as-built drawings and the additional work performed at no cost to the Owner.

K. The submittal of bid shall indicate that the Contractor has examined the site and the drawings and has included all required allowances in their bid. They shall also determine in advance and make allowances for the methods of installing and connecting the equipment, the means of getting equipment in to place and they shall make themselves familiar with all the requirements of the contract. No allowance will be made for any error resulting from the Contractor's failure to visit job site and to review drawings, and bid shall include costs for all required drawings and changes as outlined above.

L. The Contract Drawings indicate the extent, the general location and arrangement of equipment, piping, ductwork, etc. Equipment, piping and ductwork shall be located to avoid interference with electrical, plumbing and structural features. All locations for mechanical work shall be checked and coordinated with the building, structural, electrical work.

M. If any conflicts occur necessitating departures from the Contract Drawings, details of departures and reasons therefore shall be submitted as soon as practical for written approval, and the piping, ductwork, fixtures or equipment affected shall not be installed until approval is received.

N. Reference to Drawing Schedules:

1. Refer to equipment schedule for unit identification number and corresponding capacity and design requirements.

2. Wherever schedules or notes appear on the Drawings or in the specifications in which sizes and capacities of equipment are indicated, the equipment furnished and installed under this contract shall meet the following requirements under operating conditions:

1.4 DEFINITIONS:

A. "Provide" shall mean "provide complete in place," that is, "furnish and install."

B. "Piping" shall mean pipes, fittings, valves and all like pipe accessories connected thereto.

C. Pressure ratings specified, such as for valves and the like, is the design working pressure and is for and with reference to the fluid which the device will serve.

D. "Ductwork" shall mean ducts, plenums, compartments, casings or any like devices, including the building structure, which is used to convey or contain air.

E. "Building Boundary" shall mean exterior building walls.

F. "Mechanical Work" shall mean all work specified and shown in the Division 15, "Mechanical," categories. Mechanical Work generally includes: Plumbing, Heating, Ventilating, Air Conditioning and Fire Protection systems.

1.5 CODES AND STANDARDS:

A. All work, material or equipment shall comply with the requirements of codes, ordinances and regulations of the local Government having jurisdiction at the location of the work, including the regulations of serving utilities, and any participating Government agencies having jurisdiction.

B. The latest editions of the following Specifications, Codes and Standards shall form a part of these specifications, the same as if herein written out in full, and all materials and installations include but not be limited to:

1. CMC (California Mechanical Code)

2. ASHRAE (American Society of Heating, Refrigeration and Air Conditioning)

3. UL (Underwriters' Laboratories, Inc.)

4. California State Division of Industrial Safety

5. CBC (California Building Code)

6. NFPA (National Fire Protection Association)

7. California Administrative Code, Title 24

8. Requirements of the State Fire Marshall

9. National Electrical Code

10. ASTM (American Society for Testing and Materials)

11. AGA (American Gas Association)

12. OSHA

13. CPC (California Plumbing Code)

C. No requirement of these drawings and specifications shall be construed to void any of the provisions of the above standards. No apparatus, equipment, device or construction shall be installed which will provide a cross connection permitting any backflow or siphonage from any source into the domestic water supply system.

1.6 PERMITS AND FEES:

Obtain all permits, patent rights, and licenses that are required for the performing of the work by all laws, ordinances, rules and regulations, or orders of any officer and/or body, give all notices necessary in connection therewith, and pay all fees relating thereto and all costs and expenses incurred on account thereof. No work shall be covered before inspection by the jurisdictional authority and the Engineer.

1.7 SUPERVISION AND COOPERATION:

A. The Contractor shall include the services of experienced superintendents for each sub-section who shall be constantly in charge of the work, together with the qualified journeymen, helpers, and laborers, required to properly unload, install, connect, adjust, start, operate and test the work involved, including equipment and materials furnished by others.

B. The work under this section shall be in cooperation with the work of other trades to prevent conflict or interference and to aid rapid completion of the overall project.

1.8 PROJECT SITE VISIT:

Periodic visits to the project site by the Engineer are for the expressed purpose of verifying compliance with the contract documents. Such site visits shall not be construed as construction supervision, i.e., the Engineer assumes no responsibility for providing a safe place for the performance of the work by the Contractor or the Contractor's employees or the safety of the supplies of the Contractor. Neither shall such site visits relieve the Contractor of the responsibility for the discovery of their own errors and the correction of them, nor of the responsibility of properly performing the work.

1.9 COORDINATION:

A. The Contractor shall be responsible for providing all information, drawings or layouts of equipment or work under this section which affect the work of the other trades.

B. In case changes in the indicated locations or arrangements are necessary due to developed conditions in the construction, or rearrangement of furnishings, or equipment, these changes shall be made without extra cost to the Owner, provided the change is ordered before work directly connected is installed, and no extra materials are required.

1.10 EXISTING UTILITIES:

A. The location of utilities shown on the plumbing plans is the best known information available at time of design. The Contractor shall contact the appropriate agencies and

confirm the information and make arrangements for connection thereto, prior to excavation and installation of any piping or systems.

B. Prior to installation of any waste and soil lines the Contractor shall physically verify whether the building sewer can be installed and properly connected to the sewer main. Any work requiring added expense which is caused by the Contractor to make such physical verification shall be borne by the Contractor.

1.11 UTILITY SERVICES DURING CONSTRUCTION:

All water and electric power used for construction shall be paid for by the Contractor.

1.12 SUBMITTALS AND SHOP DRAWINGS:

A. Equipment and materials shall be submitted to the Engineer for approval within 30 days after award of Contract and prior to fabrication or purchase of equipment and materials.

B. Installation of materials or ordering of equipment prior to approval of submittals is done entirely at the risk of the Contractor.

C. Unless otherwise specifically directed in the following specifications, the submittals by the Contractor to the Engineer shall be as follows:

1. Submit all items at one time in a neat and orderly manner with index tabs. A partial submittal will not be acceptable.

2. Reference catalog cuts and brochures of products to proper paragraph in specifications. Furnish numerical index by specification article number, listing product name, catalog number and reference to page number of submittal brochure.

3. Cross reference individual catalog numbers of substitute products to number of specified materials.

4. Bind submittal in booklet form.

5. Submit manufacturers' certification that equipment meets or exceeds the minimum requirements as specified.

6. Where materials, equipment and installations are specified to conform with societies or agencies such as ANSI, ASHRAE, SMACNA, etc., submit certification of such compliance.

7. The submittal shall be complete and with catalog data and information properly marked to show, among other things, material capacity and performance to meet capacities or performance as specified or indicated. Arrange the submittals in the same sequence as the specifications and reference in the upper right-hand corner, the particular specification provision for which each submittal is intended. <u>Incomplete submittals will be rejected, unless prior approval for partial submittal has been obtained</u>.

8. The Contractor is responsible for confirmation of code approval of material and equipment. Certification of code conformance by the manufacturer shall be submitted for:

   a. Backflow preventors.

9. If the Contractor submits a product that is specified, a complete set of brochures, rating tables, etc., is still required for future reference.

10. Review of the submittal is only for general conformance with design concept of project and general compliance with information given in the contract documents. The Contractor is responsible for confirmation and correlation of the dimensions, quantities and sizes, for information that pertains to fabrication methods or construction techniques, and for coordination of work of all trades. Deviations from drawings and specifications shall be clearly and completely indicated (by a separate letter) in the submittal.

11. For items which are not manufactured and which have to be specifically fabricated including drawings and typical duct construction and complicated portions of ductwork, six copies of shop drawings and detail description shall be submitted. Shop drawings shall be submitted with such promptness as to allow ample time for examination and any re-submittal.

D. For duct and piping shop drawing development, the contractor shall obtain the most current architectural, structural and electrical CAD files to be overlaid on to mechanical duct and piping shop drawings.

1.13 SUBSTITUTIONS:

A. Substitution of an article, device, product, material, fixture, form or type of construction, other than those specified by name, make or catalog number is not permitted before the bid date. The contractor awarded the project, may propose substitutions as part of the submittal package as value engineering items. Written approval cannot be finalized until submittals are examined and credit to the owner is established.

B. If the use of substituted equipment results in an increase in the cost, including the work of other trades, the Contractor shall be solely responsible for payment of said increase in cost.

1.14 GUARANTEE:

A. In addition to the guarantees required elsewhere, all work, materials and equipment provided under the mechanical sections shall be guaranteed for a period of one year from the date of acceptance of the work by the Owner. Should any trouble develop during this period due to defective materials or faulty workmanship, the Contractor shall immediately furnish all necessary labor and materials to correct the trouble without cost to the Owner. The Contractor, under this guarantee, shall be responsible for all damages to any part of the premises caused by equipment furnished under this section.

B. Furnish written certified guarantee, in acceptable form, to the Owner, against defective workmanship, materials and operating equipment. Further guarantee to rebalance and

adjust entire system, or any part thereof as required for perfect operation for a period of at least one year after acceptance. Compressors shall have five year warranty. Repair, replace and make satisfactorily operative any and all defective items and work, holding the Owner free from any cost and liability in connection therewith, for the term of the guarantee.

1.15 INTERRUPTION OF SERVICES:

A. Existing services required to stay in operation in areas not remodeled shall be maintained rerouted or otherwise provided with temporary connection to prevent interruptions.

B. If impossible to prevent interruptions they shall be performed during "off-hours" and coordinated with the Owner's Representative.

C. Provide a minimum of seven (7) days written notice of interruption. Do not interrupt services without written consent of the Owner.

1.16 DAMAGE BY LEAKS:

The Contractor shall be responsible for damage to the grounds, walks, roads, buildings, furnishings, piping systems, electrical systems and their equipment and contents, caused by leaks in the piping systems being installed or having been installed herein. They shall repair at their expense all damage so caused.

1.17 EMERGENCY REPAIRS:

The Owner reserves the right to make emergency repairs as required to keep equipment in operation without voiding the Contractor's guarantee bond nor relieving the Contractor of his responsibilities.

1.18 DEMOLITION:

A. Demolition, capping and rerouting shall be performed as shown and as required to accommodate new construction.

PART 2 PRODUCTS

The specification of the mechanical products is detailed in the individual specification sections of Division 15.

PART 3 EXECUTION

3.1 INSTALLATION INSTRUCTIONS:

A. The requirements of "mechanical" installation is detailed in the individual specification sections of Division 15. In addition the following general requirements shall apply:

1. Obtain Manufacturer's printed installation instruction to aid in properly executing work of installing equipment whenever such instructions are available. Submit three copies of such instructions to the Architect prior to time of installation for use of supervising the work.

2. Erect equipment in a neat and workmanlike manner. Align, level and adjust for satisfactory operation. Install so that connecting and disconnecting of piping and accessories can be made readily, and so that all parts are easily accessible for inspection, operation, maintenance and repair. Minor deviation from arrangements shown on drawings may be made, as approved by the Architect.

3.1 PROTECTION OF PIPING SYSTEMS:

B. It shall be the responsibility of the Contractor to install and maintain pipe and equipment which is reasonably clean and free from rust, dirt, scale, etc. Where necessary, the Contractor shall provide temporary airtight covers at all pipe and equipment openings.

C. Before turning the systems over to the Owner, all piping systems shall be thoroughly flushed of all scale and dirt. Drains shall be installed at the low points to facilitate flushing of the piping systems.

3.2 PROTECTION OF AIR HANDLING SYSTEMS:

A. The Contractor shall continuously maintain adequate protection to keep dirt and foreign matter from getting into the air handling system.

3.3 PROTECTION OF ELECTRICAL SYSTEMS:

Do not route liquid filled pressure and drain piping over electrical equipment, switchboards motor control centers and the like. When unavoidable, install galvanized drain pans to prevent liquid from dripping or squirting onto such equipment.

3.4 RECORD DRAWINGS:

A. The Contractor shall keep an accurate dimensional record of the as-built locations of all work under this Contract. This record shall be kept up-to-date at all times on blue line prints as the job progresses, and shall be available for inspection at all times.

B. Upon completion of the work, obtain from the Architect one complete set of reproducible prints of the applicable Contract Documents. Record all changes and information contained on the Record Drawings onto the new set of reproducible prints in an orderly and legible manner.

C. Submit two blueline prints of the completed reproducible Record Set for approval. Make such changes and correction as may be required for final approval.

D. When final approval is received, sign the reproducible Record Set and stamp or note "As-Built" and submit to the Architect.

E. Final observation will not be made until these approved as-built drawings have been received by the Architect.

3.5 VIBRATION ELIMINATION AND CONNECTORS:

Rotating or reciprocating mechanical equipment shall be mounted on or suspended from vibration isolators to prevent vibration and structural borne noise transmission to the building. Refer to each mechanical trade section of these specifications for specific details. Flexible duct connection shall be used between all fan openings and sheet

metal work. Flexible connectors shall be used in piping connections to rotating or reciprocating equipment. See individual mechanical sections for specifications.

3.6 REQUIREMENTS FOR FINAL INSPECTION:

A. All of the following items must be completed prior to final inspections. No exception and no final payment will be made until all items are completed and approved. For specific requirements see the individual section in the Division 15 Category.

1. Cleaning equipment and premises

2. Test and balance of systems

3. Test and balance reports are reviewed by the Engineer

4. Service manual

5. Pipe and valve identification

6. Pipe and valve identification schedule

7. Operation tests

8. Operating instructions

9. As-built drawings

3.7 EARTHQUAKE RESTRAINT:

A. General:

B. All earthquake resistant designs for mechanical equipment, such as air handling units, water heaters, blowers, motors, ductwork, mechanical and plumbing piping, shall conform to the regulations of the California Building Code.

C. The restraints which are used to prevent disruption of the function of the piece of equipment because of the application of the horizontal force shall be such that the forces are carried to the frame of the structure in such a way that the frame will not be deflected when the apparatus is attached to a mounting base and equipment pad, or to the structure in the normal way, utilizing the attachments provided. Equipment, piping, ductwork, etc. shall be secured to withstand a force in any direction equal to the value shown in Table 16.

D. Piping:

1. All piping shall be secured by bracing at every fourth hanger transversely and every eighth hanger longitudinally. Bracing shall be done in accordance with the NFPA Code, and as described in paragraph "Sway Bracing for Protection Against Earthquakes," of that code.

2. As approved by code authority, the SMACNA "Guidelines for Seismic Restraints of Mechanical Systems" may be used as a guide.

E. No sway bracing is required for pipes that are installed on very short hangers (12-inches or less).

F. As approved by the code authority a bracing system as manufactured by "Superstrut" or "Pipe Shields Inc." may be used.

3.8 TESTING AND COMMISSIONING

A. Process Control Systems: The mechanical system supplier shall perform and complete system testing per Section 13490 prior to integrating the system into the overall process.

1. Factory testing shall be performed on system control panels, PLC control logic programming, HMI graphics, and network addressing prior to being shipped to the site.

2. Field testing shall be performed on equipment within the process skid. This shall include loop and component inspections for all loops or control subsystems, wiring, and calibration of all electrical devices and instruments.

3.9 ADJUSTMENTS OF SYSTEMS AND OPERATION TESTS:

A. When the work included in these specifications is complete, and at such time as directed by the Architect, the Contractor shall adjust all parts of the systems, advising the Architect when this has been done and the work is ready for their final tests. Refer to "Balancing and Testing Procedures" in Section 15800.

B. The Owner may require operation of parts or all of the systems prior to final acceptance. If it becomes necessary for temporary use of the systems before all parts are complete, the Contractor shall adjust all parts as far as possible in order to make such temporary use as effective as possible. After temporary use and before acceptance tests, all systems shall be readjusted to meet permanent operational requirements. This occupancy shall not be construed as final acceptance cost of utilities for such operation will be paid by the Owner.

C. Operation Test:

1. At completion, the Contractor shall operate all mechanical systems for a period of at least three eight-hour days to demonstrate fulfillment of the requirements of the contract. During this time all adjustments shall be made to the equipment until the entire system is in satisfactory operating condition acceptable to the Architect and the Owner.

2. Final Operation and Instruction: Upon completion of the installation of the equipment and after final acceptance, at a time approved by the Owner, the Contractor shall place a competent person at the building who shall operate the systems for a period of three eight-hour days instructing the Owner's Representatives in all details of operation and maintenance.

3. Any required instructions from manufacturer's representatives shall be given during this period. The three days specified under "Operation Test" does not substitute for these days of final operation and instruction.

4. All arrangements for operation periods shall be made through the Owner, and the Architect.

D. For specific requirements see individual Mechanical Sections.

3.10 RUBBISH REMOVAL AND CLEANING:

Upon completion of the work under this section, the Contractor shall remove all surplus materials, equipment and debris incidental to their work, and leave the premises clean and orderly.

3.11 SERVICE:

Ninety (90) days free service shall be provided after completion of the job including changing of filters. Replacement filters shall be provided by the Owner and shall be on the job site.

3.12 PAINTING:

A. Excepting piping identification specified in the specific section all painting is specified in the Painting Section of the Specifications.

B. Surfaces to be painted shall be cleaned of cement, plaster and other spills.

C. Factory finishes shall be repaired to original condition when scratched or dented.

END OF SECTION

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SECTION 15060 – POLYVINYL CHLORIDE SOLVENT WELDED PIPE

PART 1 GENERAL

1.1 THE REQUIREMENT

A. The Contractor shall furnish and install all exposed and buried solvent welded PVC piping and all appurtenant work, complete in place, including connection to existing and new structures, all in accordance with the requirements of the Contract Documents.

B. All pipe specified under this Section shall conform to the requirements of Section 15000 – Piping, General.

C. PVC gasketed pipe is specified in Division 2 - Sitework.

1.2 REFERENCE SPECIFICATIONS, CODES, AND STANDARDS

A. All work shall be performed in strict conformance with the industry standards, local laws, and ordinance specified in the General Requirements. Wherever the requirements of the specifications exceed those of these codes, the requirements of the specifications shall govern. Code compliance is mandatory. Nothing in these Contract Documents shall be construed as permitting work not in accordance with these laws and codes.

B. Commercial Standards:

ASTM D1784	Rigid PVC Compounds and Chlorinated PVC Compounds.
ASTM D1785	Specification for Poly (Vinyl Chloride) (PVC) Plastic Pipe, Schedules 40, 80, and 120.
ASTM F441	Specification for Chlorinated Poly (Vinyl Chloride) (CPVC) Plastic Pipe, Schedules 40 and 80.
ASTM D2464	Threaded Poly (Vinyl Chloride) (PVC) Plastic Pipe Fittings, Schedule 80.
ASTM D2564	Solvent Cements for Poly (Vinyl Chloride) (PVC) Plastic Pipe and Fittings.
ASTM D2774	Underground Installation of Thermoplastic Pressure Piping.
ASTM D3034	Type PSM Poly (Vinyl Chloride) (PVC) Sewer Pipe and Fittings.
ASTM D3139	Joints for Plastic Pressure Pipes using Flexible Elastomeric Seals.
ASTM D3212	Joints for Drain and Sewer Plastic Pipes Using Flexible Elastomeric Seals.
ASTM F402	Safe Handling of Solvent Cements and Primers Used for Joining Thermoplastic Pipe and Fittings.
ASTM F477	Elastomeric Seals (Gaskets) for Joining Plastic Pipe.

ASTM F656	Primers for Use in Solvent Cement Joints of Poly (Vinyl Chloride) (PVC) Plastic Pipe and Fittings.
ASTM F679	Poly (Vinyl Chloride) (PVC) Large-Diameter Plastic Gravity Sewer Pipe and Fittings
ASTM F913	Thermoplastic Elastomeric Seals (Gaskets) for Joining Plastic Pipe.

1.3 CONTRACTOR SUBMITTALS

A. For the materials and equipment items supplied under the provisions of this Section, the Contractor shall submit copies of the manufacturer's product specifications and performance details according to the requirements of Section 01340 Shop Drawings, Product Data and Samples, and the following supplemental requirements:

1. List of Pipe Fittings to be used
2. Manufacturer
3. Model Number, if applicable
4. Size and Schedule
5. Material
6. Pressure Rating
7. Catalog Data
8. Drawings

B. Manufacturer's written Quality Assurance/Control Program.

C. Certifications: The Contractor shall furnish a certified affidavit of compliance for all pipe and other products or materials furnished under this Section of the Specifications, as specified in the referenced standards.

D. All expenses incurred in making samples for certification of tests shall be borne by the Contractor at no increased cost to the Owner.

1.4 QUALITY ASSURANCE

A. Inspection: All pipe shall be subject to inspection at the place of manufacture in accordance with the requirements of the applicable referenced standards as supplemented by the requirements herein. The Contractor shall notify the Engineer in writing of the manufacturing starting date not less than 14 calendar days prior to the start of any phase of the pipe manufacture.

B. During the manufacture of the pipe, the Engineer shall be given access to all areas where manufacturing is in process and shall be permitted to make all inspections necessary to confirm compliance with the Specifications

C. Tests: Unless otherwise specified, all material used in the manufacture of the pipe shall be tested in accordance with the requirements of the applicable referenced standards.

D. The Contractor shall perform all material tests at no additional costs to the Owner. The Engineer shall have the right to witness all testing conducted by the Contractor provided that the Contractor's schedule is no delayed for the convenience of the Engineer. In addition to those test specifically required, the Engineer may request additional samples of any material for testing by the Owner. The additional samples shall be furnished at no additional cost to the Owner.

PART 2 PRODUCTS

2.1 PVC (POLYVINYL CHLORIDE) PRESSURE PIPE, SOLVENT-WELDED

A. PVC pipe shall be made from all new rigid unplasticized polyvinyl chloride and shall be Normal Impact Class 12454-B, Schedule 80, conforming to ASTM D1785, unless otherwise shown. Elbows and tees shall be of the same material as the pipe. Unless otherwise shown, joint design shall be for solvent-welded construction to the pipe manufacturer's specifications. Threaded joints shall be made with Teflon tape, only.

B. Joints: shall be joined using solvent cement in accordance with ASTM D2564 and ASTM D1784. Primers for use on solvent cement joints shall be in accordance with ASTM F656, and handling of primers and solvent cements shall conform to ASTM F402. Solvent cements shall comply with requirements for potable water use. Threaded and flanged joints shall be used where required.

2.2 CPVC (CHLORINATED POLYVINYL CHLORIDE) PRESSURE PIPE, SOLVENT-WELDED

A. CPVC pipe, for hot, corrosive solutions and where shown, shall be made from all new rigid unplasticized chlorinated polyvinyl chloride, Class 23447-B, and shall be Schedule 80 conforming to ASTM F441, with solvent-welded fittings of the same material as the pipe, unless otherwise shown. Joints shall be made to the pipe manufacturer's specifications. Threaded joints shall be made with Teflon tape, only.

B. Utility Water piping shall be ASTM F441, Cell Classification 23447, bearing NSF seal, Schedule 80. Fittings for Utility Water piping shall be ASTM F439, Cell Classification 23447, bearing NSF seal.

2.3 THREADED LUBRICANT

A. Threaded lubricant shall be Teflon tape. Lubricant, if required, shall be suitable for lubricating the parts of the joints in the assembly. The lubricant shall have no deteriorating effects on the gasket and pipe material.

2.4 SOLVENT CEMENT

A. All connections to be joined by PVC (polyvinyl chloride) solvent cement shall be industrial grade and shall conform to ASTM D2564 and shall bear a dated stamp on the container indicating the date of manufacture. Manufacture and viscosity shall be as recommended by the pipe and fitting manufacturer to assure compatibility. Primers used in solvent cement connections shall be in accordance with ASTM F656 and handling of primers and solvent cements shall conform to ASTM F402.

2.5 FLANGES

A. PVC flanges shall be supplied with all necessary gaskets, bolts, and nuts. Gaskets shall be full face, 1/16-inch thick Viton.

B. Flanges or unions for Utility Water piping shall be provided where needed to facilitate disassembly of equipment or valves. Flanges or unions shall be joined to the pipe by a solvent weld. Diameter and drilling shall conform to ANSI/ASME B16.5, Class 150.

2.6 GASKETS AND BOLTS

A. Except as otherwise provided, gaskets for flanged joints shall be in accordance with the requirements of Section 15000 – Piping, General.

B. Except as otherwise provided, bolts shall conform to the requirements of Section 05500 – Miscellaneous Metals.

C. Flange Bolts and Nuts for Utility Water piping shall be ASTM A307, Grade B, galvanized steel, with length such that, after installation, the bolts will project 1/8 to 3/8 inch beyond outer face of the nut.

2.7 PIPE INSULATION

A. Chemical piping shall be insulated as shown, in accordance with the requirements indicated.

2.8 PIPE SUPPORTS

A. Pipe Supports, hangers, anchors, and guides shall be in accordance with the requirements of Section 15006 – Pipe Supports.

PART 3 EXECUTION

3.1 DELIVERY, STORAGE, AND HANDLING

A. All pipe shall be handled or packaged in such a manner as to provide adequate protection for the pipe and the pipe ends during transportation from manufacturer, and supplier, to the site.

B. Pipe and fittings shall not be stored in direct sunlight. Pipe shall be stored in such a manner as to prevent sagging or bending. Pipe supports shall be properly and adequately supported and anchored so as to maintain the supported loads in proper position under all operating conditions without unnecessary movement or strain on any piece of equipment. Thrust blocks shall be provided where necessary to resist system pressure on fittings.

C. PVC solvent cements shall be stored in a cool place, except when actually in use during the joining process.

D. Any section of pipe that has been dented or damaged or in any other way found to be defective, either before or after placing, shall be replaced with sound pipe without additional expense to the Owner.

3.2 INSTALLATION

A. All rigid polyvinyl chloride (PVC) pipe shall be cut square, burrs removed, made up, and installed in accordance with the pipe manufacturer's recommendations, as approved. Offset shall be as recommended by the manufacturer for the maximum temperature variation between time of solvent welding and final use.

B. Pipe shall not be laid when the temperature is below 40 degrees F, nor above 90 degrees F when exposed to direct sunlight. Ends to be joined shall be shielded from direct sunlight prior to and during the laying operation.

C. Provide adequate ventilation when working with pipe joint solvent cement.

D. PVC, CPVC pipe joints shall be solvent-welded in accordance with the manufacturer's instructions. Expansion joints or pipe bends shall be provided to absorb pipe expansion over a temperature range of 100 degrees F, unless otherwise shown. Care shall be taken to provide sufficient supports, anchors, and guides, to avoid stress on the piping. The Contractor shall obtain the services of the pipe manufacturer, to instruct the pipe fitters in the correct way of making solvent welded and threaded joints. Only clean, fresh primer and solvent shall be used at all times at the recommended temperatures.

E. The installation of plastic pipe valves; fittings and tubing shall be in strict accordance with the manufacturer's technical data and printed instructions, including the use of expansion joints and/or expansion loops, necessary for the piping to tolerate a 100 degree F change in operating temperature or any straight run of greater than 40 feet.

F. All piping shall have a sufficient number of unions to allow convenient removal of piping and shall be as approved by the Engineer.

G. Particular care should be taken to avoid overstressing or breaking of the pipe at the sleeves.

H. Underground installation of PVC pipe, fittings and valves shall be as specified below and in ASTM D2774.

I. Where plastic pipe passes through walls, wall penetrations shall be made as shown on the Drawings.

J. All plastic pipe to metal pipe connections shall be made using flanged connections. Metal piping shall not be threaded into plastic fittings, valves, or couplings, nor shall plastic piping be threaded into metal valves, fittings or couplings.

K. Where small piping is specified to be PVC (polyvinyl chloride) and is not specifically described herein, it shall be Schedule 80 with solvent weld joints as specified under above for water piping.

3.3 TESTING

A. All lines shall be hydrostatically tested. Test procedures shall be as specified in Section 15000 – Piping, General and Section 02640 – Pipeline Testing and Disinfection.

B. Prior to inspection and testing, stabilize piping by bringing it approximately to operating temperature before testing.

C. Cure Period: A 24-hour cure period shall be required before the piping system is pressure tested.

D. All leaks shall be repaired and all leaking lines retested as approved by the Engineer.

3.4 SUPPORTS AND HANGERS

A. Pipe supports shall be as specified by manufacturer's recommendations and in accordance with Section 15006 – Pipe Supports.

3.5 DISINFECTION AND CLEANING

A. All lines shall be cleaned, and all potable water lines shall be cleaned and disinfected, before being put in service, in accordance with Section 02640 – Pipeline Testing and Disinfection.

3.6 PAINTING

A. All unburied polyvinyl chloride (PVC) piping shall be painted in accordance with Section 09900 – Painting and Coatings.

END OF SECTION

SECTION 15061 – DOUBLE CONTAINMENT CHEMICAL TUBING

PART 1 GENERAL

1.1 THE REQUIREMENT

A. The Contractor shall furnish and install reinforced PVC (RPVC) tubing in PVC conduit for hypochlorite, critic acid, and magnesium hydroxide chemical feed and all appurtenant work, complete in place, including connections to existing structures, all in accordance with the requirements of the CONTRACT DOCUMENTS.

B. All pipe specified under this Section shall conform to the requirements of Section 15000 – Piping, General.

1.2 CONTRACTOR SUBMITTALS

A. General: Submittals shall be in accordance with Section 01340 - Shop Drawings, Product Data and Samples.

B. Shop Drawings: CONTRACTOR shall submit shop drawings and samples in accordance with Section 01340 - Shop Drawings, Product Data and Samples.

C. Certifications: The CONTRACTOR shall furnish a certified affidavit of compliance for all pipe and other products or materials furnished under this Section of the Specifications, as specified in the referenced standards.

D. Submit a copy of manufacturer's product information and installation instructions.

1.3 QUALITY ASSURANCE

A. Inspection: All pipe shall be subject to inspection at the place of manufacture in accordance with the requirements of the applicable referenced standards as supplemented by the requirements herein. The CONTRACTOR shall notify the ENGINEER in writing of the manufacturing starting date not less than 14 calendar days prior to the start of any phase of the pipe manufacture.

B. During the manufacture of the pipe, the ENGINEER shall be given access to all areas where manufacturing is in process and shall be permitted to make all inspections necessary to confirm compliance with the Specifications

C. Tests: Unless otherwise specified, all material used in the manufacture of the pipe shall be tested in accordance with the requirements of the applicable referenced standards.

D. The CONTRACTOR shall perform all material tests at no additional costs to the OWNER. The ENGINEER shall have the right to witness all testing conducted by the CONTRACTOR provided that the CONTRACTOR's schedule is not delayed for the convenience of the ENGINEER. In addition to those tests specifically required, the Engineer may request additional samples of any material for testing by the OWNER. The additional samples shall be furnished at no additional cost to the OWNER.

PART 2 PRODUCTS

2.1 GENERAL

A. All new RPVC tubing, PVC piping, fittings, couplings, and appurtenant equipment shall be free from defects of contamination.

B. All materials of construction shall be suitable for use with the intended chemical service.

2.2 REINFORCED PVC (RPVC) TUBING

A. All buried hypochlorite and sodium bisulfite feed piping shall be RPVC tubing installed within PVC pipe conduit. PVC pipe conduit greater than 4-inches in diameter shall be as specified in Section 02597 – Polyvinyl Chloride Pressure Pipe, Rubber Joints (AWWA C900 and C905 Modified). PVC pipe conduit less than 4-inches in diameter shall be Schedule 80 PVC pipe, as specified in Section 15060 – Polyvinyl Chloride Solvent Welded Pipe. Long radius elbows shall be PVC electrical sweeps with suitable water-tight connections to the main run pipe.

B. Where double contained pipe is specified in the CONSTRUCTION DRAWINGS piping shall be RPVC tubing installed within PVC containment pipe. PVC pipe shall be as specified in Section 15060 – Polyvinyl Chloride (PVC) Pipe.

C. RPVC tubing shall be, flexible, PVC tubing with white polyester cord or nylon reinforcement embedded in transparent PVC walls. Tubing and containment pipe diameters shall be as indicated in the CONSTRUCTION DRAWINGS.

D. Tubing shall be at least 65 Durometer hardness, rated for working pressure of 200 psi, with burst pressure twice as high as the working pressure. Temperature range of tubing shall be -5°F to 150°F.

E. Compression fittings are acceptable if the resulting connections have a pressure rating equal to or greater than tubing pressure rating. In any event, maximum diameter of any element of a tube fitting shall not be greater than 1-inch.

F. Tubing shall be continuous without splices within PVC conduit.

PART 3 EXECUTION

3.1 GENERAL

A. Piping and its installation shall be in accordance with Section 15000 – Piping, General.

3.2 DELIVERY AND STORAGE

A. All plastic materials shall be stored out of direct sunlight.

3.3 TESTING

A. Testing shall be performed in accordance with the requirements of Section 15000 – Piping, General.

3.4 TRENCHING AND BACKFILL

A. Trench excavation and backfill shall conform to the requirements of Section 02200 – Earthwork.

3.5 INSTALLATION OF PIPELINES THROUGH CONCRETE STRUCTURES

A. Pipe-wall penetrations in chemical containment areas shall be leakproof type; wall sleeves shall be HDPE with ring type anchor and waterstop; closures shall be modular mechanical type with interlocking, synthetic rubber links with 316 stainless steel pressure plate and hardware. Whenever a pipeline or any material terminates at or extends through a structural wall or sump, the CONTRACTOR shall install, in advance of pouring the concrete, the fitting or special casting required for the particular penetration.

END OF SECTION

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SECTION 15080 - MECHANICAL INSULATION

PART 1 GENERAL

1.1 THE REQUIREMENT

A. The CONTRACTOR shall provide piping insulation and insulation accessories including vapor retarders, jackets, complete, in accordance with the Contract Documents.

1.2 REFERENCE SPECIFICATIONS, CODES, AND STANDARDS

ASTM C177	Standard Test Method for Steady State Heat Flux Measurements and Thermal Transmission Properties by Means of the Guarded Hot Plate Apparatus.
ASTM C195	Standard Specification for Mineral Fiber Thermal Insulating Cement.
ASTM C518	Standard Test Method for Steady State Heat Flux Measurements and Thermal Transmission Properties by Means of the Heat Flow Meter Apparatus.
ASTM C547	Standard Specification for Mineral Fiber Pipe Insulation.
ASTM C553	Standard Specification for Mineral Fiber Blanket Thermal Insulation for Commercial and Industrial Applications.
ASTM C1136	Standard Specification for Flexible, Low Permeance Vapor Retarders for Thermal Insulation.
ASTM C1290	Standard Specification for Flexible Fibrous Glass Blanket Insulation Used to Externally Insulate HVAC Ducts.
ASTM D1784	Standard Specification for Rigid Poly (Vinyl Chloride) (PVC) Compounds and Chlorinated Poly (Vinyl Chloride) (CPVC) Compounds.
ASTM E84	Standard Test Method for Surface Burning Characteristics of Building Materials.
ASTM E96	Standard Test Methods for Water Vapor Transmission of Materials.

1.3 CONTRACTOR SUBMITTALS

A. General: CONTRACTOR shall submit administrative, shop drawings, samples, and product quality control closeout submittals of all insulation products furnished in this Section and in referenced Sections.

B. Shop Drawings and Samples: Shop drawings and samples shall be submitted in accordance with the requirements of Section 01340 - Shop Drawings, Product Data and Samples.

C. Maintenance Manual: The CONTRACTOR shall provide maintenance data for all insulation products furnished for the project in accordance with Section 01730 - Operation and Maintenance Data.

1.4 QUALITY ASSURANCE

A. CONTRACTOR shall submit the following:

1. Product Data:

a. Insulation Properties: Include K factor, thickness, density, operating temperature limits, tensile strength, compressive strength, moisture absorption, flame spread and smoke developed in accordance with ASTM E 84 and corrosivity to stainless steel piping in accordance with ASTM C 795.
b. Jacket Properties: Include covering material, cover thickness, tensile strength, tear strength, permeability per ASTM E 96, flame spread and smoke developed in accordance with ASTM E 84, closure type or devices, and accessories
c. Insulating Blankets: Include materials, performance characteristics, method of attaching equipment, and listing of locations where insulating blankets will be installed.

2. Production performance test reports showing compliance with specifications

3. Laboratory Report: Provide certified laboratory report stating that insulation is not manufactured using chlorinated polymers and does not contain chlorides, bromides, sulfates, or fire-rated materials.

4. MANUFACTURER's printed installation instructions

5. List of suggested spare insulation product materials to maintain insulation.

6. List of special tools, application materials, and supplies need for insulation installation and maintenance.

B. Warranty

1. A written suppliers warranty shall be provided for the equipment specified in this section as required in accordance with the General Conditions.

PART 2 PRODUCTS

2.1 INSULATION, GENERAL REQUIREMENTS

A. Equipment shall be insulated in accordance with the schedule at the end of this section.

B. Pipe Insulation Thicknesses: Provide insulation thickness in inches in accordance with the following table. Insulation thickness shown is nominal manufacturing tolerance of 15 percent variation is permissible.

Table 1: Required Insulation Thicknesses (inches)

	Nominal Pipe Diameters				
Service Temperature Range as Designated in Insulation Schedule at End of this Section	**1 inch & less**	**1.25 to 2 inch**	**2.5 to 4 inch**	**5 to 10 inch**	**Over 10 inch**

Above 200 degrees Fahrenheit	2.0	2.5	3.0	3.5	3.5
100 to 200 degrees Fahrenheit	1.5	1.5	1.5	2.0	2.5
40 to 100 degrees Fahrenheit	0.5	1.0	1.0	1.5	2.0
Below 40 degrees Fahrenheit	1.0	1.0	1.5	2.0	2.0
Aeration Air Pipes	0.5	0.5	1.0	1.0	1.0

C. Insulation, Type 1 (Not Used)

D. Insulation, Type 2

1. Insulation Material: Preformed mineral fiberglass insulation made from glass fibers bonded with a thermosetting resin.

   a. Conform to ASTM C 547, Class 1.

2. Provide with factory installed vapor barrier.

   a. Material: White Kraft paper bound to aluminum foil meeting ASTM C 1136, Type I.
   b. Longitudinal Lap Seals: Pressure-sensitive, self-sealing longitudinal lap strip with factory applied adhesive.
   c. Circumferential Butt Seals: 4-inch wide tape or similar properties or 4-inch wide overlap with adhesive seal.
   d. Vapor Barrier Permeability: 0.02 perms or lower.
   e. Vapor Barrier Flame Spread Rating: 25 or less

3. Minimum Temperature Range: Minus 0 degrees Fahrenheit to plus 850 degrees Fahrenheit.

4. K Factor at 75 degrees Fahrenheit: Not more than 0.23 BTU – in/hr-sq ft- degree Fahrenheit.

5. Average Insulation Density: 3.3 pounds per cubic foot.

6. Maximum Moisture Absorption, Volume Percent: 0.2

7. Manufacturers or Equal:

   a. Owens-Corning Fiberglas Corp., Fiberglas SSL-II.
   b. Johns Manville, Micro-Lok Fiber Glass Insulation
   c. Knauf Fiber Glass, 1000º Pipe Insulation

E. Insulation, PFG1

1. Type PFG1 foam glass, closed-cell pipe insulation shall be Pittsburgh Corning “FOAMGLAS Hydrocal”.

2. Type PFG1 pipe insulation shall be high temperature, sectional or segmented cellular glass with U.S. Gypsum Co “B-11” bonding suitable for temperatures of

no less than 400°F. Multiple layers shall be installed for temperatures exceeding 400°F.

3. Fittings and valves shall be insulated with factory-made molded cellular glass fittings or built-up sections of pipe covering. The insulation shall conform to ASTM C552-07.

F. Insulation, DMF1

1. Type DMF1 semi-rigid type duct insulation shall be Johns Manville "800 Series Spin-Glas", Knauf "Insulation Board", or Owens-Corning “Fiberglas 705”.

2. Type DMF1 exterior insulation for rectangular ductwork shall be a semirigid, 6 pounds per cubic foot [96 kg/m3] density fiberglass material with a factory-applied all service jacket. Insulation suitable for temperatures of up to 150°F [66°C], and shall have a maximum thermal conductivity (k) of 0.23 Btu in/hr ft2 °F at 75°F [0.033 W/m °C at 24°C].

3. The insulation shall conform to ASTM C612.

G. Insulation, EFG1

1. Type EFG1 foam glass, closed-cell equipment insulation shall be Pittsburgh Corning “FOAMGLAS Hydrocal”.

2. Type EFG1 equipment insulation shall be high temperature, sectional cellular glass with U.S. Gypsum Co “B-11” bonding suitable for temperatures of no less than 400°F. Multiple layers shall be installed for temperatures exceeding 400°F.

3. Fittings and valves shall be insulated with factory-made molded cellular glass fittings or built-up sections of pipe covering. The insulation shall conform to ASTM C552-07.

2.2 PIPE JACKETS

A. Jacket, Type 1

1. Material: 28 ounces per square yard polyvinyl chloride on polyester fabric; total thickness 0.028 inches maximum

2. Fire Rating: 25 maximum flame spread, smoke developed 50 or less.

3. Color: As selected by the ENGINEER from manufacturer’s standard colors.

4. Overlap: One-inch minimum at joints and fittings.

5. Joint Seal: Self-sealing lap tape.

6. Fittings: Factory made with full thickness insulation.

7. Manufacturers or Equal:

a. Accessible Products, Thermazip TMZ 300

B. Jacket, Type 2

1. Material: Ultraviolet resistant polyvinyl chloride jacketing, 20 mil minimum thickness.

2. Fire Rating: 25 maximum flame spread, smoke developed 50 or less.

3. Color: White

4. Overlap: One-inch minimum at joints and fittings.

5. Joint Seal: PVC solvent welded or adhesive as recommended by the MANUFACTURER.

6. Fittings: Factory made with full thickness insulation.

7. Manufacturers or Equal:

a. Johns Manville, Zeston 2000 PVC
b. Proto Corp., LoSMOKE PVC
c. Speedline Smoke Safe PVC Jacketing System
d. Knauf Covering System

2.3 DUCTWORK INSULATION

A. Flexible Glass Fiber: ASTM C553; flexible, noncombustible blanket.

1. Minimum R-value: R-4.2 for ducts indoors, R-6.3 for ducts outdoors.

2. Vapor Retarder Facing: Kraft paper reinforced with glass fiber yarn and bonded to aluminized film, secured with pressure sensitive tape.

3. Maximum flame spread index: 25. Maximum smoke developed index: 50.

4. Greenguard-Certified for low emissions of total particle, formaldehyde, and other volatile organic compounds.

B. Duct Liner: ASTM C1071; flexible, noncombustible blanket with acrylic polymer meeting ASTM G21 and ASTM G22 impregnated surface and edge coat, 2.0 pcf density, minimum 1-1/2-inch thick.

1. Minimum R-value: R-4.2 for ducts indoors, R-6.3 for ducts outdoors.

2. Maximum Velocity on Coated Air Side: 5,000 ft/min.

3. Maximum flame spread index: 25. Maximum smoke developed index: 50.

4. Certified for low emissions of total particle, formaldehyde, and other volatile organic compounds.

5. Adhesive: Waterproof fire-retardant, low VOC type.

6. Liner Fasteners: Galvanized steel, self-adhesive pad or welded with press-on head.

7. Minimum acoustical performance shall be as follows:

Minimum Absorption Coefficients at Octave Bank Center Frequencies (Hz)

125	250	500	1000	2000	4000	NRC
0.20	0.42	0.80	0.93	0.93	0.88	0.75

2.4 SCHEDULES

1. Process pipes shall be insulated according to the following schedule:

Process	Location	Insulation	Jacket	Service Temperature
Aeration Piping	Interior	Type 2	Type 1	Insulation thickness as required in Table 1
Aeration Piping	Exterior	Type 2	Type 2	Insulation thickness as required in Table 1
Supply and Return Ducts	Within 15 Feet of Air Conditioning Equipment	Duct Liner: 1-1/2 inch thick	None	All
Supply and Return Ducts	Ducts Not Lined	Duct Wrap: 1-1/2 inch thick	None	All
Outside Air Intake Ducts	All	Duct Wrap: 1-1/2 inch thick	None	All
Return and Relief Ducts in Mechanical Rooms	All	Duct Wrap: 1-1/2 inch thick	None	All
Exterior Ductwork	All	Duct Liner: 2 inches thick	None	All
Thermal Fluid Oil	All	PFG1	Aluminum	Insulation thickness shall be sufficient to provide a cold face temperature not to exceed 150°F.

Process	Location	Insulation	Jacket	Service Temperature
Dryer Off Gas	All between sludge dryer and condenser	DMF1	None	All
Thermal Oil Expansion Tank, Thermal Oil Pump, Thermal Oil Cooler	All	EFG1	Aluminum	Insulation thickness shall be sufficient to provide a cold face temperature not to exceed 150°F.
PW, UW	Exterior	Type 2	Type 1	30 degrees F.

a. Unless noted otherwise, use service temperature range provided in this table to establish insulation thickness as required by Table 1.
b. Install insulation on all aeration air from the discharge of blowers to a minimum of 10 feet above floor slab or as shown on drawings.

PART 3 EXECUTION

3.1 DELIVERY AND STORAGE

A. A complete set of MANUFACTURER's instructions covering storage, installation, and maintenance shall be furnished to the OWNER. Care during storage and procedures for installation shall be in strict conformance with the MANUFACTURER's instructions.

3.2 INSTALLATION

A. Install in accordance with the MANUFACTURER's printed instructions.

B. Verify piping and equipment has been tested before applying insulation materials.

C. Verify surfaces are clean and dry, with foreign material removed.

D. Exposed Piping: Locate insulation and cover seams in least visible locations.

E. Man made mineral fiber insulated pipes conveying fluids above ambient temperature:

1. Furnish factory-applied or field-applied standard jackets. Secure with pressure sensitive adhesive system on standard factory-applied jacket and butt strips.

2. Insulate fittings, joints, and valves with insulation of like material and thickness as adjoining pipe. Finish with PVC fitting covers.

F. Inserts and Shields:

1. Application: Piping or Equipment 1-1/2 inches diameter or larger.

2. Shields: Galvanized steel between pipe hangers or pipe hanger rolls and inserts.

3. Insert location: Between support shield and piping and under finish jacket.

4. Insert configuration: Minimum 6 inches long, of thickness and contour matching adjoining insulation; may be factory fabricated.

5. Insert material: Compression resistant insulating material suitable for planned temperature range and service.

G. Continue insulation through penetrations of building assemblies or portions of assemblies having fire resistance rating of one hour or less. Provide intumescent fire stopping when continuing insulation through assembly. Finish at supports, protrusions, and interruptions.

H. Pipe Exposed in Mechanical Equipment Rooms or Finished Spaces: Finish with PVC jacket and fitting covers.

I. Factory Insulated Equipment: Do not insulate.

J. Exposed Equipment: Locate insulation and cover seams in least visible locations.

K. Apply insulation close to equipment by grooving, scoring, and beveling insulation. Fasten insulation to equipment with studs, pins, clips, adhesive, wires, or bands.

L. Fill joints, cracks, seams, and depressions with bedding compound to form smooth surface.

M. For hot equipment containing fluids over 140 degrees F, insulate flanges and unions with removable sections and jackets.

N. Mineral fiber insulated equipment containing fluids above ambient temperature: Provide standard jackets, with or without vapor retarder, factory-applied or field-applied. Finish with glass cloth and adhesive.

O. Finish insulation at supports, protrusions, and interruptions.

P. Fittings:

1. Insulate fittings by covering with mitered sections of insulation or utilize factory made prefabricated fitting shapes.

2. Terminate preformed pipe jackets or covering at sufficient distance from flanges to permit removal of bolts.

Q. Valves

1. Insulate valves 3-inch in nominal size and larger with removable insulating blankets.

2. Size blanket to extend up to packing gland only so that replacement of packing does not require removal of insulating blanket.

R. Duct Work

1. Verify equipment and ductwork are tested and ready for installation.

2. Insulation shall be provided and installed in accordance with the California Energy Code, latest edition.

3. Install duct liner in accordance with SMACNA HVAC Duct Construction Standards - Metal and Flexible.

4. Continue insulation vapor barrier through penetrations.

5. Duct Wrap:

    a. For insulated ductwork, install vapor barrier jacket. Finish with tape. Seal vapor barrier penetrations with vapor barrier adhesive.
    b. Continue insulation through walls, sleeves, hangers, and other duct penetrations.
    c. Install without sag on underside of ductwork. Use adhesive or mechanical fasteners where necessary to prevent sagging.

6. External Ductwork Insulation:

    a. For insulated ductwork conveying air below ambient temperature install vapor barrier jacket. Finish with tape. Seal vapor barrier penetrations with vapor barrier adhesive.
    b. For insulated ductwork conveying air above ambient temperature install with or without standard vapor barrier jacket. Where service access is required, bevel and seal ends of insulation.

S. Equipment in Mechanical Equipment Rooms or Finished Spaces: Finish with canvas jacket sized for finish painting.

T. Nameplates and ASME Stamps: Bevel and seal insulation around; do not insulate over.

U. Equipment Requiring Access for Maintenance, Repair, or Cleaning: Install insulation for easy removal and replacement without damage.

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SECTION 15180 – STRAINERS

PART 1 GENERAL

1.1 THE REQUIREMENT

A. The CONTRACTOR shall provide pipe strainers where indicated, complete and operable, in accordance with the Contract Documents.

B. All strainers shall be of ample size, with the perforations suitable for each individual service, and designed for easy cleaning and removal of the strainer basket.

1.2 CONTRACTOR SUBMITTALS

A. General: CONTRACTOR shall submit administrative, shop drawings, samples, quality control, and contract closeout submittals of all equipment furnished under this Section and in referenced Sections in accordance with the requirements of Section 01340 - Shop Drawings, Product Data and Samples.

B. Shop Drawings and Samples: In addition to the requirements of Section 01340 – Shop Drawings, Product Data and Samples. CONTRACTOR shall submit the following:

1. Construction details, sizes, dimensions, weights, materials, control diagrams, electric motor data, and pressure ratings, in accordance with Section 11000 - Equipment General.

C. O & M Manuals: The CONTRACTOR shall provide operations and maintenance data for all equipment furnished for the project in accordance with Section 01730 - Operation and Maintenance Data.

D. Tools: Special tools necessary for maintenance and repair of the equipment shall be furnished as a part of the Work hereunder; such tools shall be suitably stored in metal tool boxes, and identified with the equipment number by means of stainless steel or solid plastic name tags attached to the box.

E. Spare parts list: List of suggested spare parts to maintain the equipment in service for a period of 5 years.

1.3 QUALITY ASSURANCE

A. Warranty: A written warranty shall be provided for the equipment specified in this section as required in accordance with the General Conditions.

PART 2 PRODUCTS

2.1 STRAINERS (METAL BODY)

A. Equipment Requirements: Strainers shall be of the Y-pattern or basket type, with flush connections, bronze bodies, a bottom blow off connection, and screwed ends for sizes 3-inch and smaller, and flanged ends for sizes greater than 3-inch. They shall be designed for not less than 250 psi working pressure in sizes 3-inch and smaller, and 125 psi working pressure in sizes over 3-inch. Strainers shall be of the same size as the

entering pipe and the screens shall have a free area of not less than three times the cross-sectional area of the pipe.

B. Strainers shall have tapped and plugged blow off connections and all the required piping to route blow off flows to the nearest drain, as indicated in the contract documents.

C. Screens: Unless otherwise indicated or required by the service fluid, the screens shall be of type 316 stainless steel construction, easily removable, with perforation size of 1/64 –inch diameter or closest mesh equivalent.

D. Spare parts: One spare set of screens shall be provided.

E. Manufacturers, or Equal:

1. Flexicraft.
2. Sterling.

2.2 STRAINERS (BOTTOM DUMP MODEL)

A. Where indicated in the Drawings, strainer shall be the bottom dump type with flush connections, stainless steel body, a 2-inch drain connection at the bottom of the strainer which shall allow for flushing of the inside of the screening elements. The intent of this design is that the basket does not need to be removed and taken offline for periodic cleaning of the basket. The bottom drain connection shall connect to a 2-inch drain line with a 2-inch ball valve.

B. Strainer shall have screwed ends for sizes 3-inch and smaller, and flanged ends for sizes greater than 3-inch. They shall be designed for not less than 250 psi working pressure in sizes 3-inch and smaller, and 125 psi working pressure in sizes over 3-inch. Strainer outlet pining shall be of the same size as the entering pipe and the screens shall have a free area of not less than three times the cross-sectional area of the pipe.

C. The screening basket and mesh shall be designed to allow for manual back-flushing without damaging the screening mesh.

D. The strainer shall be provided with support legs and shall not rely on the adjacent piping to support its weight.

E. If the outlet pipe is offset in the vertical direction from the entering pipe, the CONTRACTOR shall provide all the necessary elbows and fittings to route the outlet pipe back up to the same vertical plane as the entering pipe. Piping and fittings shall be of the same type as the entering pipe.

F. Screens and spare parts shall be as specified for the metal body strainers.

G. Manufacturers, or Equal:

1. R.P. Adams

2. Islip Flow Controls

2.3 STRAINERS (PLASTIC BODY)

A. Equipment Requirements: Strainers shall be of the Y-pattern type with removable screen, cap, and EPDM or Viton O-ring seal, and PVC body with screwed ends, rated for the following pressures at 70 degrees F. The O-ring seals shall be as follows, unless indicated otherwise; Viton shall be used for sodium hypochlorite; and Buna N (nitrile) shall be used for citric acid and magnesium hydroxide.

1. 150 psi for sizes 1/2 to 1 inch

2. 90 psi for sizes 1-1/2 to 2 inches

3. 60 psi for sizes 3 to 4 inches

B. Screen: The screens shall be of PVC, with a free area of twice the cross-sectional area of the pipe and 1/32-inch perforations.

C. Manufacturers, or Equal:

1. ASAHI/AMERICA

2. Hayward Industrial Products, Inc.

PART 3 EXECUTION

3.1 DELIVERY AND STORAGE

A. The requirements of Section 15000 – Piping, General apply to this section.

B. A complete set of manufacturer's instructions covering storage, installation, operation, and maintenance shall be furnished to the OWNER no later than the date the equipment is shipped. Care during storage and procedures for installation and startup of the equipment shall be in strict conformance with the manufacturer's instructions.

C. The CONTRACTOR shall prepare and load all material and articles for shipment in a manner that protects the equipment and coatings from damage in transit, shall include a packing list, and shall be responsible for and make good any and all damage. During shipping the rotating elements shall be suitably supported or disassembled to protect bearings.

D. All accessories and spare parts shall be packed separately in containers plainly marked "ACCESSORIES ONLY" or "SPARE PARTS ONLY." All packing materials shall be fire retardant. A packing list, listing the contents of each container, shall be placed in a moisture proof envelope and securely fastened to the outside of the container.

E. Finished ferrous surfaces not painted shall be properly protected to prevent rust and corrosion.

F. The finished surfaces of all exposed flanges shall be protected by strong wooden blind flanges.

3.2 INSTALLATION

A. Strainers shall be installed in accordance with the Manufacturer's printed recommendations and approved procedures submitted with the shop drawings and as indicated.

B. Unless otherwise indicated, strainers shall be provided ahead of any control valves, regulators, steam and condensate traps, and where shown, and shall be preceded by shut-off valves.

3.3 TESTING

A. All piping shall be tested in accordance with the requirements of Section 02640 – Pipeline Testing and Disinfection.

END OF SECTION

SECTION 15200 – VALVES, GENERAL

PART 1 GENERAL

1.1 THE REQUIREMENT

A. The Contractor shall provide all valves, actuators, and appurtenances, complete and operable, in accordance with the Contract Documents.

B. The provisions of this Section shall apply to all valves and valve actuators except where otherwise indicated. Valves and actuators in particular locations may require a combination of units, sensors, limit switches, and controls indicated in other Sections of the Specifications.

C. Single Manufacturer: Where two or more valves of the same type or size are required, the valves shall be furnished by the same manufacturer. Valve and valve actuators shall be provided by the valve supplier.

1.2 REFERENCE SPECIFICATIONS, CODES, AND STANDARDS

ASTM A48 Specification for Gray Iron Castings

ASTM A126 Specification for Gray Iron Castings for Valves, Flanges, and Pipe Fittings

ASTM A216 Specification for Steel Castings, Carbon Suitable for Fusion Welding for High-Temperature Service

ASTM A351 Specification for Steel Castings, Austenitic, for High-Temperature Service

ASTM A395 Specification for Ferritic Ductile Iron Pressure-Retaining Castings for Use at Elevated Temperatures

ASTM A536 Specification for Ductile Iron Castings

ASTM A515 Specification for Pressure Vessel Plates, Carbon Steel, for Intermediate- and Higher-Temperature Service

ASTM B62 Specification for Composition Bronze or Ounce Metal Castings

ASTM B584 Specification for Copper Alloy Sand Castings for General Applications.

1.3 CONTRACTOR SUBMITTALS

A. General: Submittals shall be furnished in accordance with Section 01340- Shop Drawings, Product Data and Samples

B. Shop Drawings: Shop drawings shall contain the following information:

1. Valve name, size, Cv factor, pressure rating, identification number (if any), and Specification Section number.

2. Complete information on valve actuator, including sizing calculations, manufacturer, model number, limit switches, and mounting.

3. Cavitation limits for all control valves.

4. Assembly drawings showing part nomenclature, materials, dimensions, weights, flow directions, and relationships of valve handles, handwheels, position indicators, limit switches, integral control systems, needle valves, and control systems.

5. Complete information on interior and exterior coating systems.

6. Complete wiring diagrams and control system schematics.

7. Valve Labeling: A schedule of valves to be labeled, indicating in each case the valve location and the proposed wording for the label.

C. Certifications.

1. Factory Test Data: Where indicated, signed, dated, and certified factory test data for each valve requiring certification shall be submitted before shipment of the valve. The data shall also include certification of quality and test results for factory-applied coatings.

2. Prior to shipment, the Contractor shall submit for all valves over 12 inches in size, certified, notarized copies of the hydrostatic factory tests, showing compliance with the applicable standards of AWWA, ANSI, and ASTM.

3. Manufacturer's certification of proper installation.

4. Contractor’s certification of satisfactory field testing.

D. O & M manuals: Prior to startup, the Contractor shall furnish six copies of the Operations and Maintenance Manuals for each valve type supplied for the project. The Operations and Maintenance shall conform to the requirements of Section 01730 – Operations and Maintenance Data.

E. Spare Parts List: A Spare Parts List shall contain the required information for each valve assembly, where indicated.

1.4 QUALITY ASSURANCE

A. Valves, gates, and actuators are to be engineered and manufactured under a Manufacturer’s written Quality Assurance program. The Quality Assurance program is to be in effect for at least (5) years, to include a written record for periodic internal and external audits to confirm compliance with such program.

1.5 MANUFACTURER'S SERVICE REPRESENTATIVE

A. As specified in each pump section, a manufacturer/supplier's representative shall be present at the job site for assistance during installation, equipment startup, testing, and training.

1.6 MANUFACTURER'S UNIT RESPONSIBILITY

A. Unless otherwise indicated, a single manufacturer shall be made responsible for coordination of design, assembly, testing, and furnishing of each valve type; however, the Contractor shall be responsible to the Owner for compliance with the requirements of each valve section.

PART 2 PRODUCTS

2.1 GENERAL

A. All valves shall be new and of current manufacture. All shut-off valves 6-inches and larger shall have actuators with position indicators. Buried valves shall be provided with valve boxes and covers containing position indicators and valve extensions. Manual shut-off valves mounted higher than 7-feet above working level shall be provided with chain actuators

B. VALVE SCHEDULE

1. The valve schedule is located at the end of this specification.

2. Notes:

1) Valves included and specified with package systems are included in this schedule (see notes)
2) Valve schedule includes manual valves 4 Inches and above.

2.2 VALVE COMPONENTS – GENERAL MATERIAL/PRODUCT

A. General: All materials shall be suitable for the intended application. Materials not specified shall be high-grade standard commercial quality, free from all defects and imperfections that might affect the serviceability of the product for the purpose for which it is intended. Unless otherwise specified, valve and actuator bodies shall conform to the following requirements:

1. Cast Iron: Close-grained gray cast iron, conforming to ASTM A48 - Specification for Gray Iron Castings, class as specified by the relevant AWWA standard, or to ASTM A126 - Specification for Gray Iron Castings for Valves, Flanges, and Pipe Fittings, Class B.

2. Ductile Iron: ASTM A536 - Specification for Ductile Iron Castings, or to ASTM A395 - Specification for Ferritic Ductile Iron Pressure-Retaining Castings for Use at Elevated Temperatures.

3. Steel: ASTM A216 - Specification for Steel Castings, Carbon Suitable for Fusion Welding for High-Temperature Service, or to ASTM A515 - Specification for

Pressure Vessel Plates, Carbon Steel, for Intermediate- and Higher-Temperature Service.

4. Bronze: ASTM B62 - Specification for Composition Bronze or Ounce Metal Castings, and valve stems not subject to dezincification shall conform to ASTM B584 - Specification for Copper Alloy Sand Castings for General Applications.

5. Stainless Steel: Stainless steel valve and operator bodies and trim shall conform to ASTM A351 - Specification for Steel Castings, Austenitic, for High-Temperature Service, Grade CF8M, or shall be Type 316 stainless steel.

B. Bodies: Valve bodies shall be cast, forged, or welded of the materials indicated, with smooth interior passages. Wall thicknesses shall be uniform in agreement with the applicable standards for each type of valve, without casting defects, pinholes, or other defects that could weaken the body. All welds on welded bodies shall be done by certified welders and shall be ground smooth. Valve ends shall be as indicated, and be rated for the maximum temperature and pressure to which the valve will be subjected.

C. Flanges: Valve flanges shall be in accordance with ANSI B16.1, B 16.5 and ASTM A126.

D. Bonnets: Valve bonnets shall be clamped, screwed, or flanged to the body and shall be of the same material, temperature, and pressure rating as the body. The bonnets shall have provision for the stem seal with the necessary glands, packing nuts, or yokes.

E. Valve Stems: Valve stems shall be of the materials indicated, or, if not indicated, of the best commercial material for the specific service, with adjustable stem packing, O-rings, Chevron V-type packing, or other suitable seal. Where subject to dezincification, bronze valve stems shall conform to ASTM B62, containing not more than 5 percent of zinc or more than 2 percent of aluminum, with a minimum tensile strength of 414 MPa (60,000 psi), a minimum yield strength of 276 MPa (40,000 psi), and an elongation of at least 10 percent in 50 mm (2 inches.) Where dezincification is not a problem, bronze conforming to ASTM B584 may be used.

F. Internal Parts: Internal parts and valve trim shall be as indicated for each individual valve. Where not indicated, valve trim shall be of Type 316 stainless steel or other best suited material.

G. Valve Operators: All valve operators, regardless of type, shall be manufactured, installed, adjusted, and tested by the valve manufacturer at the manufacturer plant. All valves shall open counter-clockwise unless otherwise shown or specified.

H. Position Indicators: All shut-off valves 14-inch and larger, shall have operators with position indicators. Where buried, these valves shall be provided with valve boxes and covers containing extensions and position indicators at the ground surface.

I. Valve Boxes and Covers: Valve box and cover shall be cast iron. Where valve boxes house position indicators, the valve box shall conform to the requirements of the position indicator manufacturer. All covers shall be imprinted as shown on the Drawings.

J. All valves shall be furnished complete with the accessories required to provide a functional system.

K. Valve Actuators: Unless otherwise indicated, electrical and manual valve actuators shall be in accordance with Section 13446 – Electrical Operators for Valves and Gates and Section 15201 – Valve and Gate Actuators, respectively.

L. Valve labeling: Except when such requirement is waived by the Engineer in writing, a label shall be provided on all valves except for hose bibbs. The label shall be of 1/16-inch plastic or stainless steel, minimum 2 inches by 4 inches in size, as indicated in Section 15005 - Piping Identification Systems, and shall by permanently attached to the valve or on the wall adjacent to the valve as directed by the Engineer.

M. Valve Marking: All valve bodies shall be permanently marked in accordance with MSS SP25 - Standard Marking Systems for Valves, Fittings, Flanges, and Unions.

2.3 SPARE PARTS

A. Where indicated, the Contractor shall furnish the required spare parts suitably packaged and labeled with the valve name, location, and identification number. The Contractor shall also furnish the name, address, and telephone number of the nearest distributor for the spare parts of each valve. All spare parts are intended for use by the Owner, only after expiration of the guarantee period. Responsibility for spare parts shall conform to the requirements of Section 01750 – Spare Parts and Maintenance Materials.

2.4 PROTECTIVE COATING

A. The exterior surfaces of all valves and the wet interior surfaces of all ferrous valves of sizes 4 inches and larger shall be coated in accordance with Section 09900 – Paint and Coatings. The valve Manufacturer shall certify in writing that the required coating has been applied and tested in the manufacturing plant prior to shipment, in accordance with these Specifications. Flange faces of valves shall not be epoxy coated.

B. Where surfaces have been shop painted but have been damaged during delivery, storage or assembly, or where shop coats have deteriorated, these surfaces shall be properly cleaned and retouched or repainted with matching paint.

2.5 BUTTERFLY VALVES – AWWA C504

A. General: Butterfly valves shall conform to ANSI/AWWA C504 (latest revision), with the options and exceptions as noted below:

1. Valves shall be of the size indicated on the valve schedule.

2. Valves shall be short body or wafer-type valves unless noted otherwise on the valve schedule.

3. All butterfly valves shall have a minimum class rating of class 150B unless noted otherwise.

4. The interior passage of butterfly valves shall not have any obstructions or stops.

5. Valves 750 mm (30-inches) of large shall have a wide diameter not smaller than 38 mm (1 ½-inches) less the normal valve size

6. The inside diameter shall be measured at the inside diameter of the seat or the smallest inside diameter location.

7. Unless indicated otherwise, all butterfly valves shall have ANSI 125 lb flanged ends conforming to the requirements of AWWA C504.

8. Body: The valve body shall be constructed of gray iron, ductile iron or alloy-gray iron

9. Disc: The disc shall be of ductile iron, ASTM A536 Grade 65-45-12, Nylon 11 Coated or ASTM A126 Class B cast iron.

10. Seat: Seats for valves smaller than 30" shall be bonded to the body or clamped to the disc edge. The disc-mounted seats shall be retained on the disc by means of an ASTM A167 or A240 Type 304 stainless steel ring and cap screws. The seats shall be positively clamped or bonded into the disc or body of the valve. The seat shall be food grade EPDM. The seat design of the 30" or larger valves shall allow for replacement and field adjustment of the full 360 degree circumference without dismantling the operator, disc, or shaft and without removing the valve from the pipeline.

11. Shaft: The shaft shall be of one-piece construction, of ASTM A276 or A240 Type 304 stainless steel. The shaft shall be provided with a machined groove or chamfer on the top end of the shaft, indicating the precise disc position on the shaft.

12. Shaft Seals: Shaft seals shall be designed for use with standard split-V type packing, or other acceptable seal.

13. Actuator: Actuators shall be in accordance with Section 13446 – Electrical Operators for Valves and Gates and Section 15201 - Valve and Gate Actuators.

B. Manufacturers, or Equal:

1. De Zurik Corporation

2. Henry Pratt Company

3. M & H Valve Company

4. Mueller Company

2.6 BUTTERFLY VALVES FOR AIR AND FOUL SERVICE

A. General: Butterfly valves for air systems shall be specifically designed for this service and meet or exceed the design, strength, performance, and testing standards of ANSI/AWWA C 504 - Rubber Seated Butterfly Valves. They shall be suitable for pressures from vacuum to 125 psi, and temperatures from minus 40 degrees F to 250 degrees F.

1. Butterfly valves used for air flow control shall be high performance type. Materials shall be certified per ANSI B16.34. The valve shall be designed for extreme cycling. The shaft shall be stainless steel.

B. Body: The valve body shall be of cast iron as specified previously in this section, with wafer, lug, or flanged design as indicated, drilled to ANSI B 16.1 Class 125.

C. The disc shall be designed with the air-profile or other suitable shape. Sprayed or plated disc edges are not acceptable. Disc materials shall be:

1. Ductile iron conforming to ASTM A536, or

2. Cast iron conforming to ASTM A 48 or ASTM A 126 with an edge of monel, Type 316 stainless steel, or nickel.

D. Seat: The elastomer seat shall be in the body. It shall be field-replaceable without special tools. The seat material shall be Ethylene-Propylene-Diene Monomer (EPDM), or other suitable material, to provide a tight shut-off at the above-mentioned temperatures.

E. Shaft: The valve shaft shall be of Type 316 or 304 stainless steel, with sufficient strength to allow for the increased torque for air service.

F. Bearings: All shaft bearings shall be of the self lubricating corrosion resistant sleeve type.

G. Packing: The packing shall be of the adjustable or self adjustable (O-ring) type, suitable for the temperature and service conditions.

H. Actuators: All valve actuators shall be in accordance with Section 13446 – Electrical Operators for Valves and Gates and and Section 15201 - Valve Actuators. They shall be sized for air service applications, with the torque condition after 3 years of service. Manual actuators shall allow for positive throttling and locking in any position from open to closed.

I. Testing: All valves shall be factory leak tested in accordance with ANSI/AWWA C 504.

J. Manufacturers, or Equal:

1. De Zurik Corporation

2. Keystone Valve - USA

3. RodNEY HUNT COMPANY (24" AND LARGER)

2.7 BALL VALVES (6-INCH AND LARGER)

A. General: Unless otherwise indicated, all ball valves shall be in accordance with ANSI/AWWA C507 - Standard for Ball Valves 6 in. through 48 in., API 6D - American

Petroleum Institute, Specification for Pipeline Valves, or API 607 - American Petroleum Institute, Fire Test for Soft-Seated Valves (Div. of Refining), suitable for velocities up to 35 fps, temperatures up to 125 degrees F, and design pressures to 150 psi.

B. Materials of Construction

1. Body: Gray iron, ductile iron or cast steel with flanged ends.

2. Balls: The balls shall be gray iron, ductile iron or cast steel and shaft or trunnion mounted.

3. Stems: The valve stems shall be of the blow-out proof design, of stainless steel, or other acceptable construction, with reinforced Teflon seal.

4. Seats: Valves shall be single or double seated to accommodate the potential flow directions in the associated pipeline with seating materials in conformance with AWWA C507 and shall have not less than one thrust bearing. Seats shall be rubber or metal per the recommendation of the valve manufacturer for the specific service.

C. Actuators: In conformance with Section 13446 and Section 15201.

D. Manufacturers, or Equal:

1. Apco Willamette

2. Golden-Anderson Industries, Inc.

3. Grove Valve and Regulator Company

4. Neles-Jamesbury, Inc.

5. NIBCO, Inc.

6. Walworth Company

2.8 DEWATERED SLUDGE SYSTEM BALL VALVES

A. Dewatered Sludge System Ball valves 4 inches and smaller shall have a minimum pressure rating of 200 psi at a temperature of 150°F. Valve body shall be aluminum bronze (ASTM B148, Alloy C95400) or bronze (ASTM B62 or ASTM B584, Alloy C83600). Ball and stem shall be Type 316 stainless steel or bronze (ASTM B21, Alloy C48500). Seat and seals shall be Teflon. Ends shall be flanged, flat faced ASME B16.5, Class 150. Valves shall be Neles-Jamesbury Style 5150, McCanna Series S151-BR, or equal.

B. Dewatered sludge system ball valves 4 inches through 12 inches shall have a minimum pressure rating of 450 psi at a temperature of 150°f. Valve body shall be carbon steel (ASTM A216). Ball and stem shall be type 316 stainless steel or bronze (ASTM B21, Alloy C48500). Seat and seals shall be teflon. Ends shall be flanged, flat faced ASME B16.5, Class 300. Valves shall be Jamesbury Style 9300 or equal.

2.9 METAL BALL VALVES (4-INCH AND SMALLER)

A. General: Unless otherwise indicated, general purpose metal ball valves in sizes up to 4-inch shall have actuators in accordance with Section 13446 – Electrical Operators for Valves and Gates and Section 15201 - Valve and Gate Actuators.

B. Unless otherwise noted, metal ball valves shall be provided on utility water lines and dryer system drain lines.

C. Materials of Construction

1. Body: All metal ball valves up to 1-1/2-inch (incl.) in size shall have bronze or carbon steel 2-or 3-piece bodies with screwed ends for a pressure rating of not less than 600 psi WOG. Valves 2-inch to 4-inch in size shall have bronze or carbon steel 2-or 3-piece bodies with flanged ends for a pressure rating of ANSI 125 psi or 150 psi, unless otherwise indicated.

2. Balls: The balls shall be solid chrome plated brass or bronze, or stainless steel, with standard port (single reduction) or full port openings.

3. Stems: The valve stems shall be of the blow-out proof design, of bronze, stainless steel, or other acceptable construction, with reinforced Teflon seal.

4. Seats: The valve seats shall be of Teflon or Buna-N, for bi-directional service and easy replacement.

D. Manufacturers, or Equal:

1. Conbraco Industries, Inc. (Apollo).

2. ITT Engineered Valves.

3. Neles-Jamesbury, Inc.

4. NIBCO, Inc.

5. Watts Regulator

6. Worcester Controls

2.10 METAL BALL VALVES (COMPRESSED AIR, NITROGEN GAS)

A. General: Unless otherwise noted, metal ball valves for compressed air and nitrogen gas service shall conform to the requirements in this section.

B. Rating: 800 psi nonshock cold WOG

C. Code: ASME B16.34

D. Type: in-line, three piece, bolted body, full

E. Body/Bonnet: ASTM A105, forged steel or ASTM A216-WCB, cast steel

F. Seat: Reinforced Teflon

G. Ball: ASTM A108-CS, chrome plated

H. Stem: ASTM A108-CS

I. Thrust Waster: Reinforced Teflon

J. Stem Seal: Reinforced Teflon

K. End Connection: Socket weld

L. Temp. Limitations: -20 to 400°F Lever

M. Manufacturers: Contromatics "C-1122-BB-DL", Conbraco Industries "Apollo 83-200 Series", Neles-Jamesbury "4DX2200TT" Contromatics “C-1122-BB-DLConbraco Industries “Apollo 83R-200 Series”, Neles-Jamesbury “4DX2200TT” Conbraco Industries “Apollo 83R-242”

2.11 PLASTIC BALL VALVES

A. General: Plastic ball valves for corrosive fluids shall be made of polyvinyl chloride (PVC), chlorinated polyvinyl chloride (CPVC), or polyvinylidene fluoride (PVDF), as recommended by the Manufacturer for the specific application. All valves shall have manual actuators in accordance with Section 15201 - Valve and Gate Actuators, unless otherwise indicated. The valves shall be suitable for a maximum working non-shock pressure of 150 psi at 73 degrees F for PVC, with decreasing ratings for higher temperatures and other plastics.

B. Materials of Construction

1. Body: All plastic ball valves shall have union ends or flanged ends to mate with ANSI B16.5, class 150, for easy removal.

2. Balls: The balls shall have full size ports and Teflon seats. All body seals, union O-ring seals, and stem seals shall be corrosion resistant for the fluid and field application.

C. Manufacturers, or Equal:

1. Hayward Valves

2. ASAHI-America.

3. George Fischer, Inc.

4. NIBCO Inc., (Chemtrol)

5. Watts Regulator

2.12 METAL BODY DIAPHRAGM VALVES

A. Materials of Construction:

1. Valve Body: Cast-iron to ASTM A126 - Class B, or ductile iron to ASTM A395 with PVDF lining.

2. Valve ends: Flanged to ANSI/ASME B16.5 125 lb. rating, or screwed, as indicated.

3. The valve bonnet shall be match the valve body material with bolts and nuts of stainless steel and the stem/bonnet seals of Viton O-rings.

B. Diaphragm: The diaphragms of all valves shall be of the best suitable material for any given service. Unless otherwise recommended by the manufacturer, the diaphragm material shall be chlorosulfonated polyethylene such as Hypalon or equal, except that the diaphragms for valves in chlorine solution and chlorine gas lines shall be Teflon. All diaphragms shall be of rugged, reinforced construction, be oil resistant, and be designed for long life.

C. Manufacturers, or Equal:

1. ITT Dia-Flo (Grinnell)

2. Mc Canna, Inc.

2.13 PLASTIC BODY DIAPHRAGM VALVES

A. Materials of Construction: Unless otherwise indicated, valve bodies shall be of PVC, CPVC, PP, or PVDF construction, as best-suited for each individual service, with union ends, screwed ends, socket-welded ends, or flanged ends to ANSI/ASME B16.5 125 lb. dimensions, as indicated. The valve bonnets shall be flanged and of the same material as the valve body. The valve stem shall be of carbon steel or stainless steel with brass, bronze, or cast-iron sleeve and a compressor of aluminum, brass, bronze, or cast-iron. The bolts, nuts, and washers shall be of stainless steel and the stem and bonnet seals of Viton or Buna-N O-rings. Valves in sizes 1/2-inch through 4-inch shall have a pressure rating of 150 psi at 104 degrees F, diminishing to not less than 50 psi for larger sizes.

B. Diaphragm: The diaphragms of all valves shall be of the best-suitable material for any given service. Unless otherwise recommended by the manufacturer, the diaphragm material shall be chlorosulfonated polyethylene such as Hypalon or equal, except that the diaphragms for valves in chlorine solution and chlorine gas lines shall be Teflon. All diaphragms shall be of rugged, reinforced construction, be oil resistant, and be designed for long life.

C. Manufacturers, or Equal:

1. ASAHI/America

2. George Fischer, Inc. (+GF+)

3. ITT Dia-Flo (Grinnell)

4. Mc Canna, Inc.

2.14 METAL-SEATED GATE VALVES (3-INCH AND LARGER)

A. General: Metal-seated gate valves for water and sewage service shall conform to ANSI/AWWA C500 - Metal-Seated Gate Valves for Water Supply Service.

1. The design working water pressure shall be 200 psig for valves 12 inches and smaller and 150 psig for larger valves.

2. The valves may be of the double-disc type for tighter shut-off, or of the solid-wedge type, with rising or non-rising stem.

3. For sewage or fluids containing solids, an outside thread shall be used.

B. Materials of Construction: The valve bodies shall be of cast iron or ductile iron, with flanged, bell and spigot, or mechanical joint-ends as indicated. Body and bonnet wall thickness shall be equal to or greater than the minimum wall thickness as listed in Table 2 of ANSI/AWWA C500.

C. Valves 14-inch and larger installed in vertical pipes shall be fitted with bronze slides, tracks, rollers, and scrapers to assist the travel of the gate assembly.

D. Gate valves 14-inch and larger shall be furnished with bypass assemblies.

E. Actuators: In accordance with Section 13446 – Electrical Operators for Valves and Gates and Section 15201 - Valve and Gate Actuators.

F. Manufacturers, or Equal:

1. American Flow Control

2. Clow Valve Co.

3. Crane Valves

4. Kennedy Valve

5. M & H Valve Company

6. Milwaukee Valve Company, Inc.

7. Mueller Company (Grinnell Corp.)

8. Stockham Valves and Fittings

G. Thermal Fluid Oil Heating System

1. Rating: Class 300

2. Type: Bolted bonnet, OS&Y rising stem

3. Body/Bonnet: ASTM A 216 GR WCB

4. Trim

a. Seal Ring: ASTM A 515
b. Disc: ASTM A 216 GR WCB
c. Stem: ASTM A 276 Type 410
d. Bonnet Gasket: Spiral Stainless 304/Graphite
e. Stem Packing: Graphite

5. End Connection: Flanged , ASME B16.5, Class 300, Ring type joint

6. Temp. Limitations: -20 to 800°F

7. Valve Operator: Handwheel or chainwheel depending on height above finished floor

8. Manufacturers: WalWorth Industries "Cast Steel Fig 5206RTJ " or equal

2.15 KNIFE-GATE VALVES (2- TO 96-INCH)

A. General: Knife-gate valves shall be of the flanged or wafer design, with raised face and resilient seats for positive seating. The valves shall be rated for tight shut-off at the following pressures:

1. Valve Sizes 4- to 12-Inch: 150 psi (bi-directional).

2. Valve Sizes Larger Than 12-Inch: 50 psi.

B. Materials of Construction: Wetted parts shall be constructed of Type 316 stainless steel and the gates shall be finish-ground on both sides to prevent packing or seat damage. Valves 2- to 12-inch in size shall be furnished with cast stainless steel bodies; valves 14-inch and larger shall have semi-steel bodies with stainless steel linings. The valve stem shall be of stainless steel with a long life packing.

C. Actuators: In accordance with Section 13446 – Electrical Operators for Valves and Gates and Section 15201 - Valve and Gate Actuators.

D. Manufacturers, or Equal:

1. DeZurik Corporation

2. Fabri-Valves

3. Rovang, Inc.

2.16 RESILIENT-SEATED GATE VALVES (3- TO 16-INCH)

A. General: Resilient-seated gate valves may be provided in lieu of metal-seated double-disc or solid-disc gate valves, at the discretion of the Engineer.

B. Materials of Construction: Resilient-seated gate valves shall conform to ANSI/AWWA C509 - Resilient-Seated Gate Valves for Water and Sewerage Systems. The valves shall be suitable for a design working water pressure of 200 psig, with flanged, bell and spigot, or mechanical joint ends.

1. The valve body, bonnet, and disc shall be of cast iron or ductile iron and the disc or body shall be rubber-coated.

2. Body and bonnet wall thickness shall be equal to or greater than the minimum wall thickness as listed in Table 2 of ANSI/AWWA C509.

3. The stem, stem nuts, glands, and bushings shall be of bronze, with the stem seal per ANSI/AWWA C509.

C. Actuators: In accordance with Section 13446 – Electrical Operators for Valves and Gates and Section 15201 - Valve and Gate Actuators.

D. Manufacturers, or Equal:

1. American Flow Control

2. Clow Valve Co.

3. Kennedy Valve

4. M & H Valve Company

5. Mueller Company (Grinnell Corp.)

6. Stockham Valves and Fittings

2.17 GATE VALVES (SMALLER THAN 3-INCH)

A. General: Gate valves, smaller than 3-inch, for general purpose use, shall be non-rising stem, heavy-duty type for industrial service, with screwed or soldered ends to match the piping. All valves shall have a pressure rating of minimum 125 psi steam, and 200 psi coldwater, unless otherwise indicated.

B. Materials of Construction

1. Body: The bodies shall have union bonnets of bronze conforming to ASTM B62 - Specification for Composition Bronze or Ounce Metal Castings.

2. Stems: The stems shall be of bronze conforming to ASTM B62, or ASTM B371 - Specification for Copper-Zinc-Silicon Alloy Rod. The solid wedges shall be of bronze conforming to ASTM B62.

3. Handwheels and stem seals: The valves shall have malleable iron handwheels, unless otherwise indicated, and stem seals shall be of Teflon-impregnated or other acceptable non-asbestos packing.

C. Manufacturers, or Equal:

1. Crane Company

2. Milwaukee Valve Company

3. Wm. Powell Company

4. Stockham Valves and Fittings

5. Walworth Company

D. Thermal Fluid Oil Heating System

1. Rating: Class 800

2. Type: Bolted bonnet, OS&Y rising stem Solid Wedge

3. Body/Bonnet: ASTM A 105

4. Trim

a. Seal Ring, Disc, and Stem to anufacturer's standard
b. Bonnet Gasket: Spiral wound
c. Stem Packing: Graphite

5. End Connection: Socket weld, ASME B16.34

6. Temp. Limitations: -20 to 750°F

7. Valve Operator: Handwheel

8. Manufacturers: Vogt "13111" or equal

2.18 PLASTIC GATE VALVES (1-1/2- TO 14-INCH)

A. Construction: Plastic gate valves shall have PVC bodies with ANSI 150 lb. flanged ends, and polypropylene or CPVC-SBR-lined plugs for tight shut-off. The non-rising stem shall be of PVC or Type 304 stainless steel construction, with O-ring seal. The valves shall have a coldwater pressure rating of 150 psig for sizes 1-1/2- through 8-inch, 110 psig for size 10-inch, and 70 psig for sizes 12- and 14-inch.

B. Actuators: Unless otherwise indicated, PVC gate valves shall have manual handwheel actuators with position indicators, in accordance with Section 15201 - Valve and Gate Actuators.

C. Manufacturers, or Equal:

1. Hayward Valves

2. ASAHI/America

2.19 LUBRICATED PLUG VALVES (1/2-INCH TO 36-INCH)

A. General: Lubricated plug valves shall be the tapered plug top-entry type, with flanged ends for sizes 3-inch and larger, and flanged or screwed ends for smaller valves, as indicated. The valve shall be rated for ANSI Class 150 or as indicated, between service temperatures of minus 20 to plus 100 degrees F.

B. Materials of Construction

1. Body and Top Plate: The body and top plate shall be of cast steel conforming to ASTM A216 - Specification for Steel Castings, Carbon Suitable for Fusion Welding for High-Temperature Service, or other acceptable cast or forged steel.

2. Plug: The plug shall be of steel or cast iron and the stem shall be of stainless steel or alloy steel, with weather seal and Teflon impregnated packing. The valve body and plug shall have smoothly-finished water passages free from sharp corners when the plug is in the wide-open position.

3. Sealant System: The valves shall be provided with fittings designed to feed a sealant through a check-valve protected passage in the stem, through the side, or through a stainless steel tube for worm-gear actuated or buried valves. There shall be ducts or grooves in the face of the plug to insure the maintenance of a closed, pressurized sealant system between all contact surfaces of moving parts. All surfaces of the plug shall be coated with a dry film lubricant, such as polyfluoride or equal, to suit the service, permanently bonded to the metal surfaces. Sealant for LP gas service shall be the Manufacturer's recommended type. The plug shall be held toward the seat by factory-adjusted gland assemblies set for proper sealing and operating torque. The gland assemblies shall be adjustable from the valve exterior and shall utilize either spring washers or gland deflection to allow plug unseating when pressurized sealant is injected.

C. Actuators: Unless otherwise indicated, valves 3-inch and smaller shall be lever-actuated; larger valves shall be equipped with manual worm-gear actuators. Valve actuators shall be in accordance with Section 13446 – Electrical Operators for Valves and Gates and Section 15201 - Valve and Gate Actuators.

D. Lubricating Gun: The Contractor shall furnish a manual lubricating gun for lubricated plug valves in sizes up to 6-inch, inclusive. For larger valves, the Contractor shall furnish a pneumatically-operated lubricating gun and a manual lubricating gun. For installations of more than 6 lubricated plug valves, the number of guns furnished shall be doubled. The guns shall be of the same Manufacturer as the valves. Guns shall each be equipped with flexible connectors, pressure gauge, safety valve, and be furnished in labeled tool boxes with operating instructions.

E. Manufacturers, or Equal:

1. Nordstrom Valves, Inc.

2. Serck Audco Valves

2.20 ECCENTRIC PLUG VALVES (1/2-INCH TO 72-INCH)

A. General: Eccentric plug valves shall be of the non-lubricated, eccentric plug design.

B. Performance: Unless otherwise indicated, all eccentric plug valves shall have a pressure rating of not less than 150 psi WOG, for bubble-tight shut-off in the standard flow direction, and 25 psi WOG in the reverse flow direction. When equipped with worm gear actuator, the pressure rating shall be 150 psi WOG in both directions. The stem seal shall consist of field adjustable packing, replaceable without removal of the actuator, or of self-adjusting U-cup packing.

C. Materials of Construction

1. Body: Valve body shall be cast iron conforming to ASTM A126 with ANSI 125 lb. flanged ends for valves 3-inch and larger, and screwed or flanged ends for smaller sizes.

2. Plugs and Shafts: The plugs and shafts shall be of solid cast iron or ductile iron conforming to ASTM A536 and the plugs shall be lined with a resilient coating, best suited for the specific service.

3. Seats: The seats shall be of nickel or stainless steel welded to the body. Eccentric plug valves for digester gas service shall have Type 316 stainless steel plugs and suitable resilient seating of Viton.

4. Stem Seal: Shall be of a self adjusting elastomer U-cup design. The stem seal elastomer shall be the same as the plug elastomer. O-rings are not acceptable.

5. Bearings: All top and bottom shaft bearings shall be of permanently lubricated stainless steel, or Teflon coated stainless steel. Grit seals of Teflon, Nylatron, or similar suitable material shall be at the top and bottom plug journals o-ring style grit seals are unacceptable.

6. Port Flow Way: 2-1/2” to 12”, the flow way shall be round, 100 percent area, full port design. Valves greater than 12”, the flow way shall be round or rectangular, 100 percent area full port design. Flow coefficients for 2-1/2” valves to 36” shall comply with the following table:

	21/2”	3”	4”	5”	6”	8”	10”	12”
Minimum Cv	360	635	1120	2000	2359	4182	7073	8366
	14”	16”	18”	20”	24”	30”	36”	
Minimum Cv	8,505	9,365	11,196	16,131	21,343	36,445	47,871	

D. Actuators: Unless otherwise indicated, all eccentric plug valves 3-inch and smaller shall have operating levers; all larger valves shall have worm-gear actuators. Valve actuators shall be in accordance with Section 13446 – Electrical Operators for Valves and Gates and Section 15201 - Valve and Gate Actuators.

E. Protective coating: The body shall be lined with a suitable elastomer, where required for a special service, or it shall be epoxy-lined in accordance with Section 09900 – Paint and Coatings.

F. Manufacturers, or Equal:

1. Milliken

2. Val Matic -Cam Centric

2.21 METAL BALL VALVES (THERMAL FLUID 3” AND SMALLER)

A. General: Ball valves for thermal fluid service shall be in-line, full port type.

B. Rating: Class 300, High Performance

C. Body/Bonnet: Carbon Steel ASTM A216

D. Ball: ASTM A108 Type 1215 or ASTM A216

E. Stem: ASTM A108 Type 1215

F. Stem Seal: PTFE

G. End Connection: Flanged or Threaded End

H. Temperature Limitations: -20 to 500°F

I. Valve Operator: Lever

J. Manufacturers, or Equal:

1. Conbraco Industries “Apollo 88A-900 Series”

PART 3 EXECUTION

3.1 DELIVERY AND STORAGE

A. The Contractor shall prepare and load all material and articles for shipment in a manner that protects the equipment and coatings from damage in transit, shall include a packing list, and shall be responsible for and make good on any and all damage.

B. All accessories and spare parts shall be packed separately in containers plainly marked “ACCESSORIES ONLY” or “SPARE PARTS ONLY.” All packing materials shall be fire retardant. A packing list, listing the contents of each container, shall be placed in a moisture proof envelope and securely fastened to the outside of the container.

3.2 INSTALLATION

A. General: All valves, actuating units, stem extensions, valve boxes, and accessories shall be installed in accordance with the Manufacturer's written instructions and as indicated. All gates shall be adequately braced to prevent warpage and bending under the intended use. Valves shall be firmly supported to avoid undue stresses on the pipe. Where applicable, valves shall be installed with the seat upstream.

B. Access: All valves shall be installed with easy access for actuation, removal, and maintenance and to avoid interference between valve actuators and structural members, handrails, or other equipment.

C. Valve Accessories: Where combinations of valves, sensors, switches, and controls are indicated, the Contractor shall properly assemble and install such items so that all systems are compatible and operating properly. The relationship between interrelated items shall be clearly noted on shop drawing submittals.

3.3 TESTING

A. General: All valve testing shall be in accordance with applicable standards of AWWA, ANSI, and ASTM.

B. Factory Testing: As a minimum, unless otherwise indicated or specified by the applicable AWWA, ANSI or ASTM standards, each valve body 4 inches and larger shall be tested hydrostatically to 1.5 times its rated 100 degrees F design water-working pressure, for a period of 5 minutes, without showing any leaks or loss of pressure. In addition, each valve 4 inches and larger shall undergo a functional test to demonstrate satisfactory operation throughout its operating cycle, and a closure test at rated 100 degrees F water-working pressure for a period of 5 minutes to demonstrate tight shut-off. Stem seal leakage shall not be a cause for rejection. All valves 3 inches and smaller shall undergo the Manufacturer's standard test.

C. Performance Testing: All valves shall be tested with the piping system in accordance with Section 02640 – Pipeline Testing and Disinfection. Field testing will be witnessed by the Engineer or Construction Manager. The Contractor shall furnish three days advance notice of field testing.

3.4 SUPPLEMENTS

A. The supplements listed below, following “END OF SECTION”, are part of this Specification.

1. Valve Schedule. See Section 13446 for actuator type descriptions for Electric Actuated Valves.

END OF SECTION

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VALVE SCHEDULE (MANUAL VALVES 6 INCH AND GREATER)

VALVE NO.	LOCATION	DESCRIPTION	VALVE TYPE	SIZE (IN)	NOTES
12-V-02-RAS	Screenings/Grit	RAS Isolation Valve No. 2	Plug	10	
12-V-03-RAS	Screenings/Grit	RAS Throttling Valve No. 1	Plug	18	On existing 18" RAS line at headworks
12-V-04-RAS	Screenings/Grit	RAS Throttling Valve No. 2	Plug	18	
21-V-01-AA	Oxidation Ditch 1	Zone 1E Air Isolation Valve No. 1	Butterfly	10	
21-V-03-AA	Oxidation Ditch 1	Zone 1F Air Isolation Valve No. 3	Butterfly	8	
21-V-05-AA	Oxidation Ditch 1	Zone 1G Air Isolation Valve No. 5	Butterfly	8	
21-V-07-AA	Oxidation Ditch 1	Zone 1H Air Isolation Valve No. 7	Butterfly	6	
22-V-01-AA	Oxidation Ditch 2	Zone 2E Air Isolation Valve No. 1	Butterfly	10	
22-V-03-AA	Oxidation Ditch 2	Zone 2F Air Isolation Valve No. 3	Butterfly	8	
22-V-05-AA	Oxidation Ditch 2	Zone 2G Air Isolation Valve No. 5	Butterfly	8	
22-V-07-AA	Oxidation Ditch 2	Zone 2H Air Isolation Valve No. 7	Butterfly	6	
22-V-09-AA	Oxidation Ditch 2	Isolation Valve Between Ditch 2 & 1	Butterfly	16	
22-V-10-AA	Blower Building	Isolation from Blower building	Butterfly	24	
23-V-01-AA	Aeration Basin 3	Zone 3E Air Isolation Valve No. 1	Butterfly	8	
23-V-03-AA	Aeration Basin 3	Zone 3F Air Isolation Valve No. 3	Butterfly	6	
23-V-05-AA	Aeration Basin 3	Zone 3G Air Isolation Valve No. 5	Butterfly	6	
23-V-07-AA	Aeration Basin 3	Zone 3H Air Isolation Valve No. 7	Butterfly	4	
23-V-09-AA	Aeration Basin 3	Isolation from Blower Building	Butterfly	16	
23-V-10-UW	Aeration Basin 3	UW Isolation	Ball	2	
23-V-11-UW	Aeration Basin 3	UW Isolation	Ball	2	
23-V-12-UW	Aeration Basin 3	UW Isolation	Ball	2	
23-V-01-PD	Aeration Basin 3	Pumped Drain Isolation	Plug	16	Pumped drain valves to match existing OD1 and OD2 pumped drain valves.
23-V-02-PD	Aeration Basin 3	Pumped Drain Isolation - Influent Basin	Plug	16	Pumped drain valves to match existing OD1 and OD2 pumped drain valves.
24-V-01-AA	Aeration Basin 4	Zone 4E Air Isolation Valve No. 1	Butterfly	8	
24-V-03-AA	Aeration Basin 4	Zone 4F Air Isolation Valve No. 3	Butterfly	6	

VALVE NO.	LOCATION	DESCRIPTION	VALVE TYPE	SIZE (IN)	NOTES
24-V-05-AA	Aeration Basin 4	Zone 4G Air Isolation Valve No. 5	Butterfly	6	
24-V-07-AA	Aeration Basin 4	Zone 4H Air Isolation Valve No. 7	Butterfly	4	
24-V-09-UW	Aeration Basin 3	UW Isolation	Ball	2	
24-V-10-UW	Aeration Basin 3	UW Isolation	Ball	2	
24-V-11-UW	Aeration Basin 3	UW Isolation	Ball	2	
24-V-01-PD	Aeration Basin 4	Pumped Drain Isolation	Plug	16	Pumped drain valves to match existing OD1 and OD2 pumped drain valves.
36-V-03-RAS	RAS Pump Station	Suction Header Isolation Valve No. 2	Plug	14	
36-V-04-RAS	RAS Pump Station	Clarifier No. 3 Isolation Valve	Plug	14	
36-V-08-RAS	RAS Pump Station	RAS Pump No. 5 Suction Valve	Plug	14	
36-V-09-RAS	RAS Pump Station	RAS Pump No. 5 Check Valve	Swing Check	14	
36-V-10-RAS	RAS Pump Station	RAS Pump No. 5 Discharge Valve	Plug	14	
36-V-11-RAS	RAS Pump Station	RAS Pump No. 6 Suction Valve	Plug	14	
36-V-12-RAS	RAS Pump Station	RAS Pump No. 6 Check Valve	Swing Check	14	
36-V-13-RAS	RAS Pump Station	RAS Pump No. 6 Discharge Valve	Plug	14	
36-V-01-S	RAS Pump Station	Scum Pump No. 3 Suction Valve	Plug	6	
36-V-02-S	RAS Pump Station	Scum Pump No. 4 Suction Valve	Plug	6	
51-V-11-WAS	WAS Storage	Influent Flowmeter Bypass Valve	Plug	8	
51-V-12-WAS	WAS Storage	Influent Flowmeter Isolation Valve No. 1	Plug	6	
51-V-13-WAS	WAS Storage	Influent Flowmeter Isolation Valve No. 2	Plug	6	
51-V-04-AA	WAS Storage	Blower No. 1 Check Valve	Check	10	Blower vendor provided
51-V-05-AA	WAS Storage	Blower No. 1 Butterfly Valve	Butterfly	10	Blower vendor provided
51-V-06-AA	WAS Storage	Blower No. 2 Check Valve	Check	10	Blower vendor provided
51-V-07-AA	WAS Storage	Blower No. 2 Butterfly Valve	Butterfly	10	Blower vendor provided
51-V-08-AA	WAS Storage	Storage Tank No. 1 Air Isolation Valve	Butterfly	6	
51-V-09-AA	WAS Storage	Storage Tank No. 2 Air Isolation Valve	Butterfly	6	
51-V-10-AA	WAS Storage	Storage Tank No. 3 Air Isolation Valve	Butterfly	6	
52-BV-01-DWS	Dewatered Cake Feed System	DWS Pump 1 Cleanout	Ball	4	

VALVE NO.	LOCATION	DESCRIPTION	VALVE TYPE	SIZE (IN)	NOTES
52-BV-02-DWS	Dewatered Cake Feed System	DWS Pump 1 Isolation	Ball	8	
52-BV-03-DWS	Dewatered Cake Feed System	DWS Pump 2 Cleanout	Ball	4	
52-BV-04-DWS	Dewatered Cake Feed System	DWS Pump 2 Isolation	Ball	8	
52-V-01-UW	Utility Water System	UW Isolation	Butterfly	4	
52-V-01-TFR	Thermal Fluid System	TFR From Paddle Dryer	Gate	6	
52-V-01-TFS	Thermal Fluid System	TFS To Paddle Dryer	Gate	6	
52-V-02-TFR	Thermal Fluid System	TFR From Paddle Dryer	Gate	6	
52-V-02-TFS	Thermal Fluid System	TFS To Paddle Dryer	Gate	6	
52-V-02-FA	Dryer-Off Gas	Dryer Off Gas Discharge Isolation	Butterfly	8	

VALVE SCHEDULE (ELECTRIC ACTUATED VALVES)

VALVE NO.	LOCATION	DESCRIPTION	VALVE TYPE	SIZE (IN)	ACTUATOR TYPE	NOTES
21-V-02-AA	Oxidation Ditch 1	Zone 1E Air Motorized Valve No. 2	Butterfly	10	3B	
21-V-04-AA	Oxidation Ditch 1	Zone 1F Air Motorized Valve No. 4	Butterfly	8	3B	
21-V-06-AA	Oxidation Ditch 1	Zone 1G Air Motorized Valve No. 6	Butterfly	8	3B	
21-V-08-AA	Oxidation Ditch 1	Zone 1H Air Motorized Valve No. 8	Butterfly	6	3B	
22-V-02-AA	Oxidation Ditch 2	Zone 2E Air Motorized Valve No. 2	Butterfly	10	3B	
22-V-04-AA	Oxidation Ditch 2	Zone 2F Air Motorized Valve No. 4	Butterfly	8	3B	
22-V-06-AA	Oxidation Ditch 2	Zone 2G Air Motorized Valve No. 6	Butterfly	8	3B	
22-V-08-AA	Oxidation Ditch 2	Zone 2H Air Motorized Valve No. 8	Butterfly	6	3B	
23-V-02-AA	Aeration Basin 3	Zone 3E Air Motorized Valve No. 2	Butterfly	8	3B	
23-V-04-AA	Aeration Basin 3	Zone 3F Air Motorized Valve No. 4	Butterfly	6	3B	
23-V-06-AA	Aeration Basin 3	Zone 3G Air Motorized Valve No. 6	Butterfly	6	3B	
23-V-08-AA	Aeration Basin 3	Zone 3H Air Motorized Valve No. 8	Butterfly	4	3B	
24-V-02-AA	Aeration Basin 4	Zone 4E Air Motorized Valve No. 2	Butterfly	8	3B	
24-V-04-AA	Aeration Basin 4	Zone 4F Air Motorized Valve No. 4	Butterfly	6	3B	
24-V-06-AA	Aeration Basin 4	Zone 4G Air Motorized Valve No. 6	Butterfly	6	3B	
24-V-08-AA	Aeration Basin 4	Zone 4H Air Motorized Valve No. 8	Butterfly	4	3B	
27-V-13-AA	Blower Building	Blower 1 Blow Off Valve	Butterfly	4	1A	
27-V-14-AA	Blower Building	Blower 1 Isolation Valve	Butterfly	14	1A	

VALVE NO.	LOCATION	DESCRIPTION	VALVE TYPE	SIZE (IN)	ACTUATOR TYPE	NOTES
27-V-23-AA	Blower Building	Blower 2 Blow Off Valve	Butterfly	4	1A	
27-V-24-AA	Blower Building	Blower 2 Isolation Valve	Butterfly	14	1A	
27-V-33-AA	Blower Building	Blower 3 Blow Off Valve	Butterfly	4	1A	
27-V-34-AA	Blower Building	Blower 3 Isolation Valve	Butterfly	14	1A	
27-V-43-AA	Blower Building	Blower 4 Blow Off Valve	Butterfly	4	1A	
27-V-44-AA	Blower Building	Blower 4 Isolation Valve	Butterfly	14	1A	
51-V-01-WAS	WAS Storage	Storage Tank No. 1 Influent Isolation	Plug	8	3A	
51-V-02-WAS	WAS Storage	Storage Tank No. 2 Influent Isolation	Plug	8	3A	
51-V-03-WAS	WAS Storage	Storage Tank No. 3 Influent Isolation	Plug	8	3A	
51-V-04-WAS	WAS Storage	Storage Tank No. 1 Effluent Isolation	Plug	10	3A	
51-V-05-WAS	WAS Storage	Storage Tank No. 2 Effluent Isolation	Plug	10	3A	
51-V-06-WAS	WAS Storage	Storage Tank No. 3 Effluent Isolation	Plug	10	3A	
51-V-08-WAS	WAS Storage	WAS Modulating Valve No. 1	Plug	8	3B	
51-V-10-WAS	WAS Storage	WAS Modulating Valve No. 2	Plug	8	3B	
51-V-01-DEC	WAS Storage	Storage Tank No. 1 Decant Valve No. 1	Plug	8	3A	
51-V-02-DEC	WAS Storage	Storage Tank No. 1 Decant Valve No. 2	Plug	8	3A	
51-V-03-DEC	WAS Storage	Storage Tank No. 1 Decant Valve No. 3	Plug	8	3A	
51-V-04-DEC	WAS Storage	Storage Tank No. 2 Decant Valve No. 1	Plug	8	3A	
51-V-05-DEC	WAS Storage	Storage Tank No. 2 Decant Valve No. 2	Plug	8	3A	
51-V-06-DEC	WAS Storage	Storage Tank No. 3 Decant Valve No. 3	Plug	8	3A	
51-V-07-DEC	WAS Storage	Storage Tank No. 2 Decant Valve No. 1	Plug	8	3A	
51-V-08-DEC	WAS Storage	Storage Tank No. 2 Decant Valve No. 2	Plug	8	3A	
51-V-09-DEC	WAS Storage	Storage Tank No. 3 Decant Valve No. 3	Plug	8	3A	
51-V-01-D	WAS Storage	WAS Drain Valve	Plug	10	3A	
51-V-01-AA	WAS Storage	Storage Tank No. 1 Air Modulating Valve	Butterfly	6	3B	
51-V-02-AA	WAS Storage	Storage Tank No. 2 Air Modulating Valve	Butterfly	6	3B	
51-V-03-AA	WAS Storage	Storage Tank No. 3 Air Modulating Valve	Butterfly	6	3B	

SECTION 15201 – VALVE AND GATE ACTUATORS

PART 1 GENERAL

1.1 THE REQUIREMENT

A. The Contractor shall provide all valve and gate actuators and appurtenances, complete and operable, in accordance with the Contract Documents.

B. The provisions of this Section shall apply to all valves and gates, except where otherwise indicated in the Contract Documents.

C. Single Manufacturer: Where two or more valve or gate actuators of the same type or size are required, the actuators shall all be produced by the same manufacturer.

D. See Section 13446 – Electric Operators for Valves and Gates, for requirements of electric motor actuators.

1.2 REFERENCE SPECIFICATIONS, CODES, AND STANDARDS

AWWA C500	Metal-Seated Gate Valves for Water Supply Service

1.3 CONTRACTOR SUBMITTALS

A. General: Submittals shall be furnished in accordance with Section 01340 -Shop Drawings, Product Data and Samples, and Section 15200 - Valves, General.

B. Shop Drawings: Shop Drawings of all actuators shall be submitted together with the valve and gate submittals as a complete package in accordance with Section 15200 - Valves, General.

C. Certifications: Manufacturer's certificate of compliance that equipment furnished meet requirements of this specification.

D. O & M manuals: O&M manuals shall be submitted in accordance with Section 15200 - Valves, General.

1.4 MANUFACTURER'S UNIT RESPONSIBILITY

A. Where applicable, the valve and gate manufacturer shall be responsible for furnishing the valve actuators. To the extent practical, valve actuators for the entire project shall be furnished by a single Actuator Manufacturer. The valve and gate manufacturers shall coordinate with the Contractor to furnish actuators by the selected Actuator Manufacturer. Where the single Actuator Manufacturer's equipment is not compatible with a valve and gate manufacturer's equipment, the valve and gate manufacturer may use an alternative actuator upon approval by the Engineer. Valve/gate operation shall not be compromised due to valve/gate and/or actuator compatibility. The valve and gate manufacturers are responsible for providing a properly operating valve/gate system.

B. The Contractor shall coordinate with all valve and gate manufacturers to ensure that all electric operators supplied are of the same manufacturer. The intent is to receive the

same make and Manufacturer for all motor operators, all valves of a specific type, and all gates.

PART 2 PRODUCTS

2.1 GENERAL

A. General: Unless otherwise indicated, all shut-off and throttling valves, and externally-actuated valves and gates, shall be provided with manual or power actuators. The Contractor shall furnish all actuators complete and operable with mounting hardware, motors, gears, controls, wiring, solenoids, handwheels, levers, chains, and extensions, as applicable. All actuators shall be capable of holding the valve in any intermediate position between fully-open and fully-closed without creeping or fluttering. All wires of motor-driven actuators shall be identified by unique numbers.

B. Materials: All actuators shall be current models of the best commercial quality materials and liberally-sized for the maximum expected torque. All materials shall be suitable for the environment in which the valve or gate is to be installed.

C. Mounting: All actuators shall be securely mounted by means of brackets or hardware specially designed and sized for this purpose and of ample strength. The word "open" shall be cast on each valve or actuator with an arrow indicating the direction to open in the counter-clockwise direction. All gear and power actuators shall be equipped with position indicators. Where possible, manual actuators shall be located between 48 and 60 inches above the floor or the permanent working platform.

D. Standard: Unless otherwise indicated and where applicable, all actuators shall be in accordance with ANSI/AWWA C540 - AWWA Standard for Power-Actuating Devices for Valves and Sluice Gates.

2.2 MANUAL ACTUATORS

A. General: Unless otherwise indicated, all valves and gates shall be furnished with manual actuators. Valves in sizes up to and including 4 inches shall have direct acting lever or handwheel actuators of the manufacturer's best standard design. Larger valves and gates shall have gear-assisted manual actuators, with an operating pull of maximum 60 pounds on the rim of the handwheel. All buried and submerged gear-assisted valves, all gates, all gear-assisted valves for pressures higher than 250 psi, all valves 30 inches in diameter and larger, and where so indicated, shall have worm-gear actuators, hermetically-sealed and grease-packed, where buried or submerged. All other valves 6 inches to 24 inches in diameter may have traveling-nut actuators, worm-gear actuators, spur- or bevel-gear actuators, as appropriate for each valve.

B. Buried Valves: Unless otherwise indicated, all buried valves shall have extension stems to grade, with square nuts or floor stands, position indicators, and cast-iron or steel pipe extensions with valve boxes, covers, and operating keys. Where so indicated, buried valves shall be in cast-iron, concrete, or similar valve boxes with covers of ample size to allow operation of the valve actuators. Covers of valve boxes shall be permanently labeled as requested by the local Utility Company or the Engineer. Wrench-nuts shall comply with AWWA C500 - Metal - Seated Gate Valves for Water Supply Service, and a minimum of 2 operating keys, or one key per 10 valves, whichever is greater, shall be furnished. All buried valves shall have an operator shaft extension from the valve or valve operator to 6 inches below finished grade.

C. Chain Actuator: Manually-activated valves with the stem located more than 7 feet above the floor or operating level shall be furnished with chain drives consisting of sprocket-rim chain wheels, chain guides, and operating chains, and be provided by the valve manufacturer. The wheel and guide shall be of ductile-iron, cast-iron, or steel, and the chain shall be hot-dip galvanized steel or stainless steel, extending to 5 feet 6 inches above the operating floor level. The valve stem of chain-actuated valves shall be extra strong to allow for the extra weight and chain pull. Hooks shall be provided for chain storage where chains interfere with pedestrian traffic.

D. Floor Boxes: Hot-dip galvanized cast-iron or steel floor boxes and covers to fit the slab thickness shall be provided for all operating nuts in or below concrete slabs. For operating nuts in the concrete slab, the cover shall be bronze-bushed.

E. Manual Worm-Gear Actuator: The actuator shall consist of a single or double reduction gear unit contained in a weather-proof cast-iron or steel body with cover and minimum 12-inch diameter handwheel. The actuator shall be capable of 90-degree rotation and shall be equipped with travel stops capable of limiting the valve opening and closing. The actuator shall consist of spur or helical gears and worm-gearing. The spur or helical gears shall be of hardened alloy steel and the worm-gear shall be alloy bronze. The worm-gear shaft and the handwheel shaft shall be of 17-4 PH or similar stainless steel. All gearing shall be accurately cut with hobbing machines. Ball or roller bearings shall be used throughout. Actuator output gear changes shall be mechanically possible by simply changing the exposed or helical gearset ratio without further disassembly of the actuator. All gearing shall be designed for a 100 percent overload.

F. Traveling-Nut Actuator: The actuator shall consist of a traveling-nut with screw (Scotch yoke) contained in a weather-proof cast-iron or steel housing with spur gear and minimum 12-inch diameter handwheel. The screw shall run in 2 end bearings, and the actuator shall be self-locking to maintain the valve position under any flow condition. The screw and gear shall be of hardened alloy steel or stainless steel, and the nut and bushings shall be of alloy bronze. The bearings and gear shall be grease-lubricated by means of grease nipples. All gearing shall be designed for a 100 percent overload.

PART 3 EXECUTION

3.1 DELIVERY AND STORAGE

A. General: Delivery and storage shall be in accordance with Section 15200 – Valves, General.

3.2 INSTALLATION

A. All valve and gate actuators and accessories shall be installed in accordance with Section 15200 - Valves, General. Actuators shall be located to be readily accessible for operation and maintenance, without obstructing walkways. Actuators shall not be mounted where shock or vibrations will impair their operation, nor shall the support systems be attached to handrails, process piping, or mechanical equipment.

B. Contractor shall field verify all dimensions and existing conflicts prior to ordering material.

3.3 TESTING

A. All valve actuators shall be tested in accordance with Section 15200 - Valves, General.

END OF SECTION

SECTION 15203 – CHECK VALVES

PART 1 GENERAL

1.1 THE REQUIREMENT

A. The Contractor shall provide check valves and appurtenances, complete and operable, in accordance with the Contract Documents.

B. The requirements of Section 15200 - Valves, General, apply to this Section.

1.2 REFERENCE SPECIFICATIONS, CODES, AND STANDARDS

ANSI/ASME B16.1	Cast Iron Pipe Flanges and Flanged Fittings
ANSI/ASME B1.20.1	Pipe Threads, General Purpose
ANSI/ASME B16.5	Pipe Flanges and Flanged Fittings
ANSI/AWWA C508	Swing-Check Valves for Waterworks Service, 2 in. through 24 in. NPS
ASTM A126	Specification for Gray Iron Castings for Valves, Flanges, and Pipe Fittings
ASTM B16	Specification for Free-Cutting Brass Rod, Bar, and Shapes for Use in Screw Machines
ASTM A48	Specification for Gray Iron Castings for Valves, Flanges, and Pipe Fittings ASTM B61 Specification for Steam or Valve Bronze Castings
ASTM B62	Specification for Composition Bronze or Ounce Metal Castings
ASTM B148	Specification for Aluminum-Bronze Sand Castings

1.3 CONTRACTOR SUBMITTALS

A. The Contractor shall furnish submittals in accordance with Section 15200 - Valves, General.

B. Shop Drawings: Shop drawings shall be in accordance with Section 15200 - Valves, General.

C. Certifications: Certifications shall be in accordance with Section 15200 - Valves, General. Affidavit of compliance that check valves meet the requirements of the contract documents and the provisions of AWWA Standards where applicable.

D. O & M manuals: O & M manuals shall be in accordance with Section 15200 - Valves, General.

1.4 QUALITY ASSURANCE

A. Quality assurance shall be in accordance with Section 15200 - Valves, General.

1.5 MANUFACTURER'S SERVICE REPRESENTATIVE

A. A manufacturer/supplier's representative shall be present at the job site for a minimum of one half man day, travel time excluded, for assistance during installation, equipment startup, testing, and training.

1.6 MANUFACTURER'S UNIT RESPONSIBILITY

A. Unless otherwise indicated, a single Valve Manufacturer shall be made responsible for coordination of design, assembly, testing, and furnishing of each valve type; however, the Contractor shall be responsible to the Owner for compliance with the requirements of each valve type.

PART 2 PRODUCTS

2.1 SWING CHECK VALVES (3-INCH AND LARGER)

A. General: Swing check valves for water, utility water, sewage, sludge, and general service shall be of the outside lever and spring or weight type, in accordance with ANSI/AWWA C508 - Swing-Check Valves for Waterworks Service, 2 in. through 24 in. NPS, unless otherwise indicated, with full-opening passages, designed for a minimum water-working pressure of 150 psi, unless shown on Contract Drawings or valve schedule. They shall have a flanged cover piece to provide access to the disc.

B. Materials of Construction

1. Body: The valve body and cover shall be of cast iron conforming to ASTM A126 - Specification for Gray Iron Castings for Valves, Flanges, and Pipe Fittings, with flanged ends conforming to ANSI/ASME B16.1 - Cast Iron Pipe Flanges and Flanged Fittings, Class 125, 250 or mechanical joint ends, as indicated.

2. Disc: The valve disc shall be of cast iron, ductile iron, or bronze conforming to ASTM B62 - Specification for Composition Bronze or Ounce Metal Castings. The disc ring shall be of Buna-N.

3. Seat: The valve seat shall be of bronze conforming ASTM B62 or B148 - Specification for Aluminum-Bronze Castings.

4. Hinge Pin: The hinge pin shall be of bronze or stainless steel.

C. Protective coating: Interior and exterior valve surfaces shall be coated in accordance with Section 15200 – Valves, General and Section 09900 – Painting and Coatings.

D. Manufacturers, or Equal:

1. Milliken

2. American Flow Control (American Cast Iron Pipe Company

3. APCO (Valve and Primer Corporation)

4. Kennedy Valve

5. Mueller Company (Grinnell Corporation)

2.2 BALL CHECK VALVES (2” TO 14”) - FLYGT

A. General: Ball check valves for water or wastewater in sizes 2-inch to 14-inch shall be suitable for a pressure of 145 psi. They shall have screwed ends, unless otherwise indicated, and screwed caps.

B. Materials of Construction

1. Body: The valve body and cap shall be nodular cast iron type GGG40/ASTM 65-45-12/SAE D4512.

2. Ball: Metal core with vulcanized Nitrile rubber covering. Ball shall sink or float as specified by the manufacturer in accordance with valve orientation. Ball shall be specified by the manufacturer for the specific head conditions of the system.

C. Protective coating: Interior and exterior valve surfaces shall be coated in accordance with Section 15200 – Valves, General and Section 09900 – Painting and Coatings.

D. Manufacturer:

1. Flygt

2.3 INTERNAL SPRING-LOADED CHECK VALVES (GLOBE STYLE)

A. General: Internal spring-loaded check valves for water pumps, compressors, gas, air, and steam shall be of the full-flow internal spring-loaded poppet type. The valves shall be designed for a water-working pressure of not less than 150 psi unless otherwise indicated.

B. Materials of Construction

1. Body: The bodies of all valves in sizes 3-inch and larger shall be of cast iron conforming to ASTM A126 - Specification for Gray Iron Castings for Valves, Flanges, and Pipe Fittings, with 125-lb flanged ends conforming to ANSI/ASME B16.1 - Cast Iron Pipe Flanges and Flanged Fittings, Class 25, 125, 250, and 800, unless otherwise indicated. Where necessary, there shall be a positive, watertight seal between the removable seat and the valve body. The stem guide shall be integrally cast with the body, or screwed into the body.

2. Valves smaller than 3 inches shall have bronze bodies with screwed ends conforming to ANSI/ASME B1.20.1 - Pipe Threads, General Purpose (inch), suitable for a minimum working pressure of 200 psi, and a temperature of 250 degrees F, unless otherwise shown indicated. The type of bronze shall be suitable for the intended service.

3. Disc and Stem: The disc and stem of all valves in sizes 3-inch and larger shall be of bronze conforming to ASTM B584 - Specification for Copper Alloy Sand Castings for General Applications or stainless steel. The stem shall have two-point bearings. The downstream bearing shall have a bronze or other suitable bushing, to provide a smooth operation.

4. Valves smaller than 3 inches shall have discs and retaining rings of Teflon, Nylon, or other suitable material, and stems of bronze, brass, or stainless steel, suitable for the intended service.

5. Stem Guide: The stem guide must be either firmly fixed in the valve body to prevent it from sliding into the adjacent pipe and damaging the pipe lining, or the valve manufacturer shall furnish each valve with one matching flange compatible with the adjacent pipe and its lining to prevent damage to the lining. The compatible flange shall be part of the shop drawing submittal.

6. Seat: All valves for general service at temperatures up to 250 degrees F shall have bubble-tight shut-off with resilient seats of Buna-N, Teflon, or other suitable material. Valves for steam service and temperatures over 250 degrees F shall have metal-to-metal seating of bronze or stainless steel, as recommended by the manufacturer for the specific service condition. All resilient seats shall be firmly attached to the seating ring by compression-molding or other acceptable method.

7. Spring: All valves in sizes 3-inch and larger shall have Type 316 stainless steel springs, and valves smaller than 3-inch shall have stainless steel or beryllium copper springs, as suitable for the service. The spring tension of the valves shall be designed for the individual pressure condition of each valve.

C. Protective coating: Interior and exterior valve surfaces shall be coated in accordance with Section 15200 – Valves, General and Section 09900 – Painting and Coatings.

D. Manufacturers, or Equal:

1. APCO (Valve and Primer Corp.)

2. CPV (Combination Pump Valve Company)

3. Miller Valve Co., Inc.

4. VAL-MATIC (Valve and Manufacturing Corporation)

2.4 PLASTIC BALL CHECK VALVES

A. General: Plastic ball check valves for corrosive fluids, in sizes up to 4-inch, shall be used for vertical up-flow conditions only, unless the valves are provided with spring actions. The valves shall be suitable for a maximum working non-shock pressure of 150 psi at 73 degrees F.

B. Materials of Construction

1. The valve bodies and balls shall be of polyvinyl chloride (PVC), chlorinated polyvinyl chloride (CPVC), polyvinylidene fluoride (PVDF), or polypropylene (PP) construction, as best suited for each individual service condition. They shall have unions with socket connections, or flanged ends conforming to ANSI/ASME B16.5 - Pipe Flanges and Flanged Fittings, class 150. All seals shall have Viton O-rings and valve design shall minimize possibility of the balls sticking or chattering.

C. Protective coating: Interior and exterior valve surfaces shall be coated in accordance with Section 15200 – Valves, General and Section 09900 – Painting and Coatings.

D. Manufacturers, or Equal:

1. Hayward Valves

2. ASAHI-AMERICA

3. George Fischer, Inc.

4. NIBCO Inc. (Chemtrol Division)

2.5 PLASTIC SWING OR Y-CHECK VALVES

A. General: Plastic swing or Y-check valves for corrosive fluids, in sizes up to 8 inches or as available, may be used for horizontal or vertical up-flow conditions. The PVC valves shall be rated for a maximum non-shock working pressure of 150 psi at 73 degrees F for sizes 3-inch and smaller. For larger sizes and other materials and temperatures the pressure rating will be lower.

B. Materials of Construction

1. The valve bodies and discs or piston shall be of PVC, PP, or PVDF construction, as best suited for each individual service condition. They shall have flanged ends conforming to ANSI/ASME B16.5 - Pipe Flanges and Flanged Fittings, class 150, and flanged top access covers, and they shall shut positively at no-flow conditions. The seats and seals shall be of EPDM, Teflon, or Viton.

C. Protective coating: Interior and exterior valve surfaces shall be coated in accordance with Section 15200 – Valves, General and Section 09900 – Painting and Coatings.

D. Manufacturers, or Equal:

1. Hayward Valves

2. ASAHI-AMERICA

3. George Fischer, Inc.

2.6 INLINE CHECK VALVES

A. General: Inline Check Valves are to be all rubber and the flow operated check type with slip-in cuff connection. The entire valve shall by ply reinforced throughout the body, disc and bill, which is cured and vulcanized into a one-piece unibody construction. A separate valve body or pipe used as the housing shall not be acceptable. The port area of the disc shall contour down, which shall allow passage of flow in one direction while preventing reverse flow. The entire valve shall fit within the pipe I.D. Once installed, the valve shall not protrude beyond the face of the structure or end of the pipe. The downstream end of the valve must be circumferentially in contact with the pipe while in the closed positions. The valve Manufacturer shall have available flow test data from an accredited hydraulics laboratory to confirm pressure drop data. The company name, plant location, valve size and serial number shall be bonded to the check valve.

B. Materials of Construction

1. The valve shall be all rubber and manufactured with no metal, mechanical hinges or fasteners, which would be used to secure the disc or bill to the valve housing.

2. Valves will be furnished with a set of 318 stainless steel expansion clamps. The clamps, which will secure the valve in place, shall be installed inside the cuff portion of the valve, based on installation orientation, and shall expand outwards by means of a turnbuckle. Each clamp shall be pre-drilled allowing the valve to be pinned and secured into position in accordance with the manufacturer's installation instructions.

C. Protective coating: Interior and exterior valve surfaces shall be coated in accordance with Section 15200 – Valves, General and Section 09900 – Painting and Coatings.

D. Manufacturers, or Equal:

1. Tideflex Technologies – CheckMate Inline Check Valve

2.7 NITROGEN CHECK VALVES

A. General: Check valves for nitrogen service sizes 1-1/2" or smaller suitable for -20 to 375F with threaded end connections.

B. Materials of Construction:

1. Valve body: 316 SS

2. Poppet: 316 SS

3. O-ring: Viton

4. Spring: SS

C. Manufacturers, or Equal:

1. Swagelok "Series C"

2. Circle Seal "Series 200"

PART 3 EXECUTION

3.1 DELIVERY AND STORAGE

A. General: Delivery and storage shall be in accordance with Section 15200 – Valves, General and applicable requirements.

3.2 INSTALLATION

A. The Contractor shall install the valves in accordance with the manufacturer instructions and Contract Documents.

B. All valves shall be installed in accordance with Section 15200 - Valves, General.

3.3 TESTING

A. All valves shall be tested in accordance with Section 15200 - Valves, General.

END OF SECTION

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SECTION 15214 – PRESSURE CONTROL VALVES

PART 1 GENERAL

1.1 THE REQUIREMENT

A. The Contractor shall provide pressure reducing valves and appurtenances, complete and operable, in accordance with the Contract Documents.

B. The requirements of Section 15200 - Valves, General, apply to this Section.

1.2 REFERENCE SPECIFICATIONS, CODES, AND STANDARDS

ASTM A48	Specification for Gray Iron Castings
ASTM A126	Specification for Gray Iron Castings for Valves, Flanges, and Pipe Fittings
ASTM A536	Specification for Ductile Iron Castings
ASTM B62	Specification for Composition Bronze or Ounce Metal Castings
ANSI/ASME B16.1	Cast Iron Pipe Flanges and Flanged Fittings, Class 25, 125, 250, and 800.
ANSI/ASME B16.42	Ductile Iron Pipe Flanges and Flanged Fittings.
ANSI/ASME B16.5	Pipe Flanges and Flanged Fittings, Class 125, 150, 250, or 300

1.3 CONTRACTOR SUBMITTALS

A. The Contractor shall furnish submittals in accordance with Section 15200 - Valves, General.

B. Shop Drawings: Shop drawings shall be in accordance with Section 15200 - Valves, General.

C. Certifications: Certifications shall be in accordance with Section 15200 - Valves, General. Affidavit of compliance that valves meet the requirements of the contact documents and the provisions of AWWA Standards where applicable. A hydrostatic factory and functional test certificate shall be submitted to the Engineer prior to delivery of the valve.

D. O & M manuals: O & M manuals shall be in accordance with Section 15200 - Valves, General.

1.4 QUALITY ASSURANCE

A. Quality assurance shall be in accordance with Section 15200 - Valves, General.

1.5 MANUFACTURER'S SERVICE REPRESENTATIVE

A. A manufacturer/supplier's representative shall be present at the job site for up to two man days, travel time excluded, for assistance during installation, equipment startup, and testing.

B. Instruction of Owner's Personnel: The training representative of the valve manufacturer shall be present at the site for up to 1 work days to instruct the personnel in the operation, adjustment, and maintenance of the valve(s).

1.6 MANUFACTURER'S UNIT RESPONSIBILITY

A. Unless otherwise indicated, a single Valve Manufacturer shall be made responsible for coordination of design, assembly, testing, and furnishing of each valve type; however, the Contractor shall be responsible to the Owner for compliance with the requirements of each valve type.

PART 2 PRODUCTS

2.1 PRESSURE RELIEF VALVES, SIZES 1 1/2 INCHES THROUGH 42 INCHES

A. General: The pressure relief valve shall open when the inlet pressure exceeds a set maximum level. It shall maintain that level and gradually close as the inlet pressure drops below the maximum pressure. The valve shall be a hydraulically operated, adjustable, pilot controlled, diaphragm or piston type globe or angle valve as indicated.

B. Performance Requirements: The valve shall be designed to operate under the following conditions:

1. Maximum Inlet Pressure (psi): 100

2. Maximum Flow Through Valve (gpm): 200

3. Valve Size (inches): 3

C. Materials of Construction

1. Body: The valve body shall be of cast iron, ASTM A48 - Specification for Gray Iron Castings, or ASTM A126 - Specification for Gray Iron Castings for Valves, Flanges, and Pipe Fittings, with 250 lb flanged ends to ANSI/ASME B16.1 - Cast Iron Pipe Flanges and Flanged Fittings, Class 25, 125, 250, and 800, or the body shall be of ductile iron to ASTM A536 - Specification for Ductile Iron Castings, with 300 lb flanged ends to ANSI/ASME B16.42 - Ductile Iron Pipe Flanges and Flanged Fittings. The valve cover shall be flanged and be of the same material as the body.

2. Flange: ANSI B16.5 Class 125, 150, 250, or 300, as indicated.

3. Valve Trim: The valve stems, springs, body seat rings, and all bolts, nuts, and washers shall be of Type 302, 303, or 316 stainless steel. The valve stems shall have top and bottom or center guides. All rubber parts shall be of Buna-N. The diaphragms shall be of Nylon-reinforced Buna-N, supported firmly between body and valve cover. The valve pistons and piston liners shall be bronze to ASTM B62 - Specification for Composition Bronze or Ounce Metal Castings.

D. Valve Controls: The valve shall be furnished with a complete, externally mounted control system, including adjustable speed control needle valves, strainer, and all necessary copper or stainless steel connecting tubing and fittings. The controls shall be capable of achieving all the flow and speed adjustment indicated.

E. Spare Parts: The following spare parts shall be furnished in accordance with Section 15200 – Valves, General:

1. One liner (for piston valves, only (Golden-Anderson or Ross)).

2. One diaphragm (for diaphragm valves, only).

F. Protective coating: Interior and exterior valve surfaces shall be coated in accordance with Section 15200 – Valves, General and Section 09900 – Painting and Coatings.

G. Manufacturers, or Equal:

1. Bermad Control Valves

2. Cla-Val Company

3. Singer Valve, Inc.

4. Golden-Anderson

5. OCV Control Valves

6. Ross Valve Mfg. Co., Inc.

7. Watts, ACV

2.2 THREADED PRESSURE RELIEF VALVES, SIZES 1/2 THROUGH 2-1/2 INCHES

A. General: The pressure relief valve shall open when the inlet water pressure exceeds a set maximum level. It shall maintain that level and gradually close as the inlet pressure drops below the maximum pressure. The valve shall be a spring and hydraulically operated, direct-acting, adjustable, diaphragm or piston type globe or angle valve as indicated.

B. Performance Requirements: The valve shall be set for a relief pressure of 100 psi.

C. Materials of Construction

1. Body: The valve body shall be bronze with threaded inlet and outlet to standard NPT and with flanged top or cast iron to ASTM A48 - 125 lb or 250 lb flanged ends to ANSI/ASME B16.1 or ductile iron to ASTM A536 – 150 lb or 300 lb flanged ends to ANSI/ASME B16.42 as specified, suitable for an inlet pressure of 300 psi. The spring shall be adjustable with an adjusting screw, to regulate the pressure setting.

2. Valve Trim: The valve trim shall be of stainless steel or bronze with stainless steel spring. The rubber seat shall be replaceable.

D. Protective coating: Interior and exterior valve surfaces shall be coated in accordance with Section 15200 – Valves, General and Section 09900 – Painting and Coatings.

E. Manufacturers, or Equal:

1. Bermad Control Valves

2. Cla-Val Company

3. Singer

4. Golden-Anderson

5. Ross Valve Mfg. Co., Inc.

2.3 TEMPERATURE AND PRESSURE RELIEF VALVES

A. General: Temperature and pressure relief valves for cold and hot water, steam, and air service, unless otherwise indicated, shall have a minimum pressure rating of 250 psi, bronze, steel, or stainless steel bodies, (to match the pipe service being connected to), adjustable spring action, screwed or flanged connections, and trim to suit individual applications. Settings shall be adjusted for each specific condition. Contractor shall coordinate the relief setting with the Dryer System Supplier when relief valves are connected to the Dryer System Supplier supplied equipment.

B. Protective coating: Interior and exterior valve surfaces shall be coated in accordance with Section 15200 – Valves, General and Section 09900 – Painting and Coatings.

C. Manufacturers, or Equal:

1. A.W. Cash Valve Mfg. Corp.

2. Consolidated (Dresser Industries Valve Division)

3. Fisher Controls Company

4. Kunkle Valve Division

5. Masoneilan (Dresser Industries Valve and Controls Division)

6. Watts Regulator Company

7. Wilkins Regulator (a Division of Zurn Industries)

2.4 THREADED PRESSURE REDUCING VALVES, SIZES 1/2 TO 2-1/2 INCHES

A. General: Pressure reducing valves shall reduce a higher upstream pressure to a pre-set, lower, constant pressure, regardless of fluctuations in the upstream pressure. The valves shall be hydraulically operated, with diaphragm or piston direct action, pilot-controlled, and shall be of the globe or angle pattern as indicated. All necessary repairs shall be possible without removing the valves from the pipeline. The smaller direct-acting valves with threaded ends shall be suitable for water or air service and shall be of the globe patterns.

B. Materials of Construction

1. Body: The valve body shall be bronze to ASTM B62 or cast steel or cast iron to ASTM A48 - 125 lb or 250 lb flanged ends to ANSI/ASME B16.1 or ductile iron to ASTM A536 – 150 lb or 300 lb flanged ends to ANSI/ASME B16.42 as specified, with a minimum pressure rating of 300 psi, and with threaded ends. The valve shall be provided with an integral or an attached strainer with access cap or plug and a flanged or threaded valve cover. The valve shall be actuated by a diaphragm.

2. Valve Trim: The valve stems, springs, body seats, and washers shall be of Series 300 stainless steel. The strainers shall be of stainless steel or monel and the diaphragms shall be of reinforced neoprene. The valve pistons and piston liners shall be bronze to ASTM B62.

C. Spare Parts: The following spare parts shall be furnished in accordance with Section 15200:

1. One liner (for piston valves, only (Golden-Anderson or Ross)).

2. One diaphragm (for diaphragm valves, only).

D. Protective coating. Interior and exterior valve surfaces shall be coated in accordance with Section 15200 – Valves, General and Section 09900 – Painting and Coatings.

E. Manufacturers, or Equal:

1. Cla-Val Company.

2. Watts, ACV.

3. OCV Control Valves (Pilot operated only)

4. Bermad Control Valves

2.5 PRESSURE REDUCING VALVES, SIZES 2 TO 12 INCHES

A. General: Pressure reducing valves shall reduce a higher upstream pressure to a pre-set, lower, constant pressure, regardless of fluctuations in the upstream pressure. When downstream pressure increases above a pre-set pressure the valve closes. The valves shall be hydraulically operated, with diaphragm or piston direct action, pilot-controlled, and shall be of the wafer, flanged, or victaulic ends as indicated.

B. Performance Requirements: Valves shall be designed to operate under the performance conditions of furnished equipment and installed pipelines.

C. Materials of Construction

1. Body: The valve body shall be bronze to ASTM B62 or cast steel or cast iron to ASTM A48 - 125 lb or 250 lb flanged ends to ANSI/ASME B16.1 or ductile iron to ASTM A536 - 150 lb or 300 lb flanged ends to ANSI/ASME B16.42, with a minimum pressure rating of 300 psi. The valve shall be provided with an integral or an attached strainer with access cap or plug and a flanged or threaded valve cover. The valve shall be actuated by a diaphragm.

2. Flange: ANSI B16.5 Class 125, 150, 250, or 300, as indicated.

3. Liner: Natural rubber, 65 durometer, Viton, EPDM, Nitrile, or Silicone as indicated. Liner retainer shall be 316 stainless steel.

4. Valve Trim: The valve stems, springs, body seats, and washers shall be of 316 stainless steel. The strainers shall be of stainless steel or monel and the diaphragms shall be of reinforced neoprene. The valve pistons and piston liners shall be bronze to ASTM B62.

D. Spare Parts: The following spare parts shall be furnished in accordance with Section 15200:

1. One liner (for piston valves, only (Golden-Anderson or Ross)).

2. One diaphragm (for diaphragm valves, only).

E. Protective coating: Interior and exterior valve surfaces shall be coated in accordance with Section 15200 – Valves, General and Section 09900 – Painting and Coatings.

F. Manufacturers, or Equal:

1. Cla-Val Company.

2. Watts, ACV.

3. OCV Control Valves

4. Bermad Control Valves

2.6 PRESSURE SUSTAINING VALVES, SIZES 2 TO 12 INCHES

A. General: Pressure sustaining valves shall maintain a minimum pre-set upper system pressure regardless of fluctuations in the downstream system. The valves shall be hydraulically operated, with diaphragm or piston direct action, pilot-controlled, and shall be of the wafer, flanged, or victaulic ends as indicated.

B. Materials of Construction

1. Body: The valve body shall be bronze to ASTM B62 or cast steel or cast iron to ASTM A48 - 125 lb or 250 lb flanged ends to ANSI/ASME B16.1 or ductile iron to ASTM A536 - 150 lb or 300 lb flanged ends to ANSI/ASME B16.42, with a minimum pressure rating of 300 psi. The valve shall be provided with an integral or an attached strainer with access cap or plug and a flanged or threaded valve cover. The valve shall be actuated by a diaphragm.

2. Flange: ANSI B16.5 Class 150 or 300, as indicated.

3. Liner: Natural rubber, 65 durometer, Viton, EPDM, Nitrile, or Silicone as indicated. Liner retainer shall be 316 stainless steel.

4. Valve Trim: The valve stems, springs, body seats, and washers shall be of 316 stainless steel. The strainers shall be of stainless steel or monel and the

diaphragms shall be of reinforced neoprene. The valve pistons and piston liners shall be bronze to ASTM B62.

C. Spare Parts: The following spare parts shall be furnished in accordance with Section 15200:

1. One liner (for piston valves, only (Golden-Anderson or Ross)).

2. One diaphragm (for diaphragm valves, only).

D. Protective coating: Interior and exterior valve surfaces shall be coated in accordance with Section 15200 – Valves, General and Section 09900 – Painting and Coatings.

E. Manufacturer, No Equal:

1. Cla-Val Company

2.7 WELL PRESSURE REDUCING VALVES, SIZES 2 TO 12 INCHES

A. General: Well pressure reducing valves shall maintain a minimum pre-set downstream pressure regardless of fluctuations in flow rate and/or varying inlet pressure and can be shut-off either remotely or manually. The valve shall be operated via a solenoid control connected to the main valve, globe or angle valve as indicated, and shall be of the wafer, flanged, or victaulic ends as indicated.

B. Materials of Construction

1. Body: The valve body shall be bronze to ASTM B62 or cast steel or cast iron to ASTM A48 - 125 lb or 250 lb flanged ends to ANSI/ASME B16.1 or ductile iron to ASTM A536 - 150 lb or 300 lb flanged ends to ANSI/ASME B16.42, with a minimum pressure rating of 300 psi. The valve shall be provided with an integral or an attached strainer with access cap or plug and a flanged or threaded valve cover. The valve shall be actuated by a solenoid.

2. Flange: ANSI B16.5 Class 150 or 300, as indicated.

3. Valve Trim: The valve stems, springs, body seats, and washers shall be of 316 stainless steel. The strainers shall be of stainless steel and the diaphragms shall be of nylon reinforced Buna-N Rubber. The valve pistons and piston liners shall be bronze to ASTM B62.

C. Spare Parts: The following spare parts shall be furnished in accordance with Section 15200:

1. One diaphragm.

2. One complete set of resilient seals and discs.

D. Protective coating: Interior and exterior valve surfaces shall be coated in accordance with Section 15200 – Valves, General and Section 09900 – Painting and Coatings.

E. Manufacturer, No Equal:

1. Cla-Val Company

2.8 WELL PRESSURE RELIEF VALVES, SIZES 2 TO 12 INCHES

A. General: Pressure relief valves shall open when the inlet pressure exceeds a set maximum level and can be used for pressure relief, pressure sustaining, back pressure or unloading functions by a by-pass system. It shall maintain a constant upstream pressure within close limits. The valve shall be a hydraulically operated, adjustable, pilot controlled, modulating valve of diaphragm type globe or angle valve as indicated.

B. Materials of Construction

1. Body: The valve body shall be bronze to ASTM B62 or cast steel or cast iron to ASTM A48 - 125 lb or 250 lb flanged ends to ANSI/ASME B16.1 or ductile iron to ASTM A536 - 150 lb or 300 lb flanged ends to ANSI/ASME B16.42, with a minimum pressure rating of 300 psi. The valve shall be provided with an integral or an attached strainer with access cap or plug and a flanged or threaded valve cover. The valve shall be actuated by line pressure through a pilot control system and feature solenoid override.

2. Flange: ANSI B16.5 Class 150 or 300, as indicated.

3. Valve Trim: The valve stems, springs, body seats, and washers shall be of 316 stainless steel. The strainers shall be of stainless steel and the diaphragms shall be of nylon reinforced Buna-N Rubber. The valve pistons and piston liners shall be bronze to ASTM B62.

C. Spare Parts: The following spare parts shall be furnished in accordance with Section 15200:

1. One diaphragm.

2. One complete set of resilient seals and discs.

D. Protective coating: Interior and exterior valve surfaces shall be coated in accordance with Section 15200 – Valves, General and Section 09900 – Painting and Coatings.

E. Manufacturer, No Equal:

1. Cla-Val Company

PART 3 EXECUTION

3.1 DELIVERY AND STORAGE

A. General: Delivery and storage shall be in accordance with Section 15200 – Valves, General.

3.2 INSTALLATION

A. All valves shall be installed in accordance with provisions of Section 15200 – Valves, General.

3.3 TESTING

A. All pressure control valves shall be tested in accordance with Section 15200 - Valves, General.

B. Factory Tests and Warranty: All valves shall be factory tested with a hydrostatic test and a functional test. The valve shall be warranted for a period of 3 years from the date of shipment to be free of defects in materials and workmanship.

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SECTION 15230 – MISCELLANEOUS VALVES

PART 1 GENERAL

1.1 THE REQUIREMENT

A. The Contractor shall provide all miscellaneous valves and appurtenances, complete and operable, in accordance with the Contract Documents.

B. The requirements of Section 15200 - Valves, General, apply to this Section.

1.2 REFERENCE SPECIFICATIONS, CODES, AND STANDARDS

AWWA C511Standard for Reduced-Pressure Principle Backflow Prevention Assembly

1.3 CONTRACTOR SUBMITTALS

A. The Contractor shall furnish submittals in accordance with Section 15200 - Valves, General.

B. Shop Drawings: Shop drawings shall be in accordance with Section 15200 - Valves, General.

C. Certifications: Certifications shall be in accordance with Section 15200 - Valves, General. Affidavit of compliance that valves meet the requirements of the contact documents and the provisions of AWWA Standards where applicable.

D. O & M manuals: O & M manuals shall be in accordance with Section 15200 - Valves, General.

1.4 QUALITY ASSURANCE

A. Quality assurance shall be in accordance with Section 15200 - Valves, General.

1.5 MANUFACTURER'S SERVICE REPRESENTATIVE

A. A manufacturer/supplier's representative shall be present at the job site for up to one half man day, travel time excluded, for assistance during installation, equipment startup, testing, and training.

1.6 MANUFACTURER'S UNIT RESPONSIBILITY

A. Unless otherwise indicated, a single manufacturer shall be made responsible for coordination of design, assembly, testing, and furnishing of each valve type; however, the Contractor shall be responsible to the Owner for compliance with the requirements of each valve type.

PART 2 PRODUCTS

2.1 AIR-VACUUM AND AIR-RELEASE VALVES

A. Air and Vacuum Valves: Air and vacuum valves shall be capable of venting large quantities of air while pipelines are being filled, and allowing air to re-enter while pipelines

are being drained. They shall be of the size indicated, with flanged or screwed ends to match piping. Bodies shall be of high-strength cast iron. The float, seat, and all moving parts shall be constructed of Type 316 stainless steel. Seat washers and gaskets shall be of a material insuring water tightness with a minimum of maintenance. Valves shall be designed for minimum 150 psi water-working pressure, unless otherwise indicated.

B. Air-Release Valves: Air-release valves shall vent accumulating air while system is in service and under pressure and be of the size indicated and shall meet the same general requirements as indicated for air and vacuum valves except that the vacuum feature will not be required. Valves shall be designed for a minimum water-working pressure of 150 psi, unless otherwise indicated.

C. Combination Air Valves for Vertical Turbine Pumps: CAV's for vertical turbine pumps (installed on the pump discharge line, immediately downstream of the pump) shall vent large quantities of air through the discharge orifice when the pump starts, close tight when liquid enters and permit large quantities of air to re-enter through the orifice when the pump stops to prevent vacuum formation in the pump suction column. The valve shall be equipped with an air release valve to exhaust accumulated air in the system while under pressure. They shall be of the size indicated, with flanged or screwed ends to match piping. Bodies shall be of high-strength cast iron. The float, seat, and all moving parts shall be constructed of Type 316 stainless steel. Seat washers and gaskets shall be of a material insuring water tightness with a minimum of maintenance. Valves shall be designed for minimum 150 psi water-working pressure, unless otherwise indicated. The discharge orifice shall be fitted with a double-acting throttling device, to regulate and restrict air venting and to establish a pressure loading on the rising suction column of water to eliminate damaging shock to the pump, controls and check valve on pump start.

D. Manufacturers:

1. APCO

2. Crispin Valve

3. GA Industries

4. Val-Matic

E. Combination Air Valves for Utility Water: Two inch and smaller combination air valves for clean water applications shall be of the integral type with a valve assembly which functions as both an air and vacuum valve and an air release valve. The valves shall be Apco/Valve and Primer "Single Body Combination Air Valves", Multiplex "Crispin Universal Air Release Valves", ARI "No. D-040", or Val-Matic "Combination Air Valves".

2.2 SEWAGE AIR RELEASE VALVES

A. Sewage Air Release Valves: Sewage air release valves shall vent accumulating gases during system operation. It shall include provisions to prevent air from re-entering when pipes are drained.

1. Each sewage air release valve shall be furnished with the following backwash accessories, fully assembled on the valve, to permit back-flushing without dismantling the valve:

a. Inlet shut-off valve.

b. Blow-off valve.

c. Clear water inlet valve.

d. 10-ft of rubber supply hose.

e. Quick disconnect couplings.

2. The automatic air release component of the valve shall be designed to operate under pressure to allow entrapped air to escape from a sewage force main line. The automatic sewage air release valve shall be designed to provide complete separation of the liquid from the sealing mechanism by creating a large air gap at the top of the valve.

3. The valve body shall be designed to prevent clogging and jamming of the float. Outward slanting valve walls shall be incorporated to prevent excess accumulation of grease and grime on valve walls. After the air in the pipeline is released through the air release component, the valve shall shut off, leaving a large air pocket in the valve body, until additional air accumulates and the air release component opening cycle is repeated.

4. The sewage air release valve shall have a spring-loaded, loose linkage between the stem and upper float to ensure that vertical and oscillating movement and vibrations of the lower float will not unseal the small orifice. The valve construction shall be S.A.E. Type 316 stainless steel or nonmetallic corrosion resistant components to prevent corrosion. Floats and seal plugs shall be foamed polyethylene. Sealing plug assembly shall be reinforced nylon and EPDM. O-ring seals shall be Nuna-N. The lower body of the valve shall be funnel shaped to prevent blockage of the lower float against the body of the valve.

B. Sewage Combination Air Valves: sewage combination air valves shall combine the characteristics of sewage air and vacuum valves and sewage air release valves by exhausting accumulated air in systems under pressure and releasing or re-admitting large quantities of air while a system is being filled or drained, respectively. Valves shall have the same general requirements as indicated for sewage air release valves except that they also shall include provisions to re-admit large quantities of air while a system is being drained.

C. Manufacturers or Approved Equal:

1. Val-Matic

2.3 BACKFLOW PREVENTER VALVES

A. General: Backflow preventers shall work on the reduced pressure principle. They shall consist of 2 spring-loaded check valves, automatic differential pressure relief valve, drain valves, and shut-off valves. The body material shall be bronze or cast iron for a working pressure of not less than 150 psi, with bronze or stainless steel trim. Drain lines with air gaps shall be provided. The backflow preventer valves shall be in accordance with AWWA C511 standard.

B. Manufacturers, or Equal:

1. Cla-Val Company

2. Febco Div. (CMB Industries)

3. Hersey Products (Grinnell Corporation)

4. Watts, ACV

5. Wilkins Regulator Division (Zurn Industries)

2.4 SEWAGE SURGE RELIEF VALVES

A. Performance Requirements: The valve shall open immediately when the system pressure exceeds the load setting, of the counterweights and shall close slowly at an adjustable speed upon return of system pressure to normal.

B. Materials of Construction: Sewage surge relief valves shall be constructed of a heavy cast-iron or cast-steel body with a welded steel disc having rubber seating face, a non-corrosive shaft for attachment of counterweight or spring-loaded arms and lever, and a complete non-corrosive cushion chamber.

C. Cushion Chamber: The cushion chamber shall be attached to the side of the valve body externally and be constructed with a piston operating in a chamber that will effectively permit the valve to be operated without any hammering action. The cushioning shall be by oil stored in an oil reservoir attached by piping and fittings to the cushion chamber. The cushion chamber shall be so arranged that the closing speed will be adjustable to meet the service requirements.

D. Manufacturers, or Equal:

1. APCO (Valve and Primer Corporation)

2. GA Industries

2.5 CORPORATION STOPS

A. Materials of Construction: Unless otherwise indicated, corporation stops shall be made of solid brass for key operation, with screwed ends with corporation thread or iron pipe thread, as required.

B. Manufacturers, or Equal:

1. Ford Meter Box Company, Inc.

2. James Jones Company (Watts, ACV)

3. Mueller Company (Grinnell Corporation)

2.6 SOLENOID VALVES

A. General: Solenoid valves shall be of the size, type, and class indicated and shall be designed for not less than 150 psi water-working pressure.

B. Materials of Construction: Valves for water, air, or gas service shall have brass or bronze body with screwed ends, stainless steel trim and spring, Teflon or other resilient seals with material best suited for the temperature and fluid handled. Solenoid valves in

corrosive environment shall have stainless steel bodies. For chemicals and all corrosive fluids, solenoid valves with Teflon bodies and springs or other suitable materials shall be used. Enclosures shall be NEMA rated in accordance with the area designations of Section 16000 – Common Work Results for Electrical. All coil ratings shall be for continuous duty. For electrical characteristics, see electrical drawings or Specifications.

C. Manufacturers, or Equal:

1. For General Duty:

a. Automatic Switch Co. (ASCO), Model "RED HAT"

b. Skinner Valve-Honeywell, Inc.

c. Magnatrol Valve Corporation

d. J. D. Gould Co.

2. For Corrosive Fluids:

a. Valcor Engineering Corporation

b. +GF+ Plastic Systems, Inc.

2.7 METAL NEEDLE VALVES

A. General: Metal Needle valves shall be rated for a minimum working pressure of 150 psi at a temperature of 125 deg. F, unless otherwise specified.

B. Materials of Construction: Needle Valves for water service shall be bronze body with one-piece stem and disc integral. The valve shall include a Teflon (PTFE) stem seal. The stem shall be 20 pitch fine thread (five turns from closed to fully open).

C. Manufacturers, or Equal:

1. Chemline

2. Asahi/America

2.8 PLASTIC NEEDLE VALVES

A. General: The valve shall be rated for a minimum working pressure of 150 psi at a temperature of 125 deg. F, unless otherwise indicated.

B. Materials of Construction: Plastic Needle Valves shall be globe-style with bodies made from PVC and threaded ends. The valve shall include a Teflon (PTFE) stem seal. The stem shall be 20 pitch fine thread (five turns from closed to fully open).

C. Manufacturers, or Equal:

1. Chemline

2. Asahi/America

2.9 WALL TYPE HYDROSTATIC PRESSURE RELIEF FLAP GATE VALVE

A. Materials of Construction: The valve body and cover shall be bronze or cast iron with a machined seating surface with a flanged end faced and drilled to ANSI 125 pound template for connection to the wall pipe as shown in the drawings. The seat shall be neoprene rubber. The cover shall be attached to the frame using a stainless steel or bronze hinge pin.

B. The valve shall be the offset design with a minimum offset of 7 degrees.

C. Manufacturers, or equal:

1. Waterman Industries

2. Clow Valve

2.10 MUD VALVES

A. Mud valves shall be cast iron body, the stem, stem nut, disc ring, and seat ring shall be bronze. The bottom connection flange shall be coordinated with the connection pipe.

B. The extension stem shall be 316 SS, with cast iron stem guides as required. As indicated on the drawings floor stands shall be provided, otherwise a 2 inch AWWA nut and T-bar shall be provided.

2.11 THREE-WAY CONTROL VALVE

A. The valve shall be an automated iron body valve with 316 stainless steel valve plug, stem and seat ring, electric actuator, remote temperature sensor and heater.

B. CONTRACTOR shall provide a 24V, 60 Hz power supply which shall accept a 120 V, 60 Hz power feed for operation of the 3-way control valve actuator. The power supply shall be installed in a NEMA rated enclosure suitable for a Class 1, Div. 2 rated environment.

C. Manufacturer, or equal

1. Honeywell, Model V5031 with Model M7284 motorized actuator.

2.12 TELESCOPING VALVES

A. Telescoping valve shall be of the appropriate diameter to match the pipe sizes shown on the Contract Drawings.

B. Tube: Valve tubes shall be of Type 316 stainless steel material and shall be manufactured from seamless pipe or tube. Tube lengths shall be as shown or noted on the Contract Drawings and must be of sufficient length to facilitate valve travel and maintain an appropriate insert depth. Valve tubes shall be a minimum of 1/8” thick and are attached to connecting stems by use of a lifting ball. All telescoping valves shall have flared tube tops.

C. Seal Flange: A stainless steel companion flange and neoprene slip seal gasket shall be provided by the valve manufacturer. The gasket shall have a minimum thickness of ¼”. The inside diameter of the gasket shall be 1/8” smaller than the outside diameter of the

valve tube to provide a friction seal. The gasket is to be sandwiched between the riser pipe flange and the companion flange. The gasket and companion flange shall be drilled to match the riser pipe flange and shall conform to the requirements of Section 15000 – Piping General.

D. Lifting Bail: The bail shall be Type 316 stainless steel material and be rigidly welded onto the tube.

E. Lift and Stems: Lifts shall be handwheel type, with UHMW polyethylene thrust bearings along with a stub acme threaded Type 304 stainless steel stem to provide automatic self-locking, infinite valve positioning. The standard rising stem lift shall use a galvanized steel square tube with torque nut design to prevent telescoping valve tube rotation. Handwheels shall be a minimum of 12-inches in diameter and shall include a clear plastic Butyrate stem cover with a mylar strip type position indicator, calibrated in ¼-inch increments to illustrate valve position. The mylar strip, provided by the valve manufacturer, will be affixed by the Contractor after installation to provide a true and accurate indication of the tube elevation by comparing it to the top of the rising stem. Stainless steel anchor bolts shall be provided for all pedestals. Cleaning and shop prime coat of the lift housing and handwheel shall be as specified in Section 09900 – Paintings and Coatings.

F. Manufacturer, or equal:

1. Waterman Industries

2. Troy Valve

PART 3 EXECUTION

3.1 DELIVERY AND STORAGE

A. General: Delivery and storage shall be in accordance with Section 15200 – Valves, General and applicable requirements.

3.2 INSTALLATION

A. Backflow preventers shall be installed in potable water lines where required by applicable codes or regulations, and wherever there is any danger of contamination, and where indicated.

B. All valves shall be installed in accordance with the manufacturer's printed recommendations, and with provisions of Section 15200 – Valves, General.

C. All backflow preventers, as well as air and vacuum release valves, shall have piped outlets to the nearest acceptable drain, firmly supported, and installed in such a way as to avoid splashing and wetting of floors and obstruction of traffic.

3.3 TESTING

A. All valves shall be tested in accordance with Section 15200 - Valves, General.

END OF SECTION

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SECTION 15250 – HYDRAULIC GATES

PART 1 GENERAL

1.1 THE REQUIREMENT

A. The CONTRACTOR shall furnish all tools, supplies, materials, equipment and labor necessary for the installation, testing, and placing into operation of all hydraulic gates with appurtenances, complete and operable, in accordance with the requirements of the Contract Documents.

B. The provisions of this Section shall apply to all hydraulic gates specified, except where otherwise specified in the Contract Documents.

C. The requirements of Section 13446 – Electrical Operators for Valves and Gates and Section 15201 – Valve and Gate Actuators, apply to this Section.

D. Single Manufacturer: Where two or more gates of the same type are required, the gates shall all be produced by the same manufacturer.

1.2 CONTRACTOR SUBMITTALS

A. General: The CONTRACTOR shall submit administrative, shop drawings, samples, quality control, and contract closeout submittals of all equipment furnished under this Section and in referenced Sections in accordance with the requirements of Section 01340 – Shop Drawings, Product Data and Samples.

B. Shop Drawings and Samples: The CONTRACTOR shall submit the following:

1. Gate name, size, pressure rating, identification number (if any), and Specification Section number.

2. Complete information on gate actuator, including sizing calculations, manufacturer, model number, limit switches, and mounting.

3. Assembly drawings showing part nomenclature, materials, dimensions, weights, and relationships of gate handles, handwheels or cranks, position indicators, limit switches, integral control systems, and control systems.

4. Complete wiring diagrams and control system schematics.

5. Gate Labeling: A schedule of gates to be labeled, indicating in each case the location and the proposed wording for the label.

C. Installation Instructions: The CONTRACTOR shall provide instructions for field procedures for erection, adjustments, inspection, and testing prior to installation of the gates.

D. O & M Manuals

1. Prior to start-up, the CONTRACTOR shall provide operations and maintenance data for all equipment furnished for the project in accordance with Section 01730 – Operation and Maintenance Data.

2. Manuals shall include printed instructions relating to proper maintenance, including lubrication, and parts lists indicating the various parts by name, number, and diagram where necessary.

3. Manuals shall be furnished in duplicate with each unit or set of identical units.

E. List of special tools, materials, and supplies furnished with equipment for use prior to and during startup. Include a list of special tools required for checking, testing, parts replacement, and maintenance.

F. Tools: Special tools necessary for maintenance and repair of the hydraulic gates shall be furnished as a part of the WORK hereunder; such tools shall be suitably stored in metal tool boxes, and identified with the equipment number by means of stainless steel or solid plastic name tags attached to the box.

G. Warranty Submittals: The CONTRACTOR shall submit equipment guarantees as outlined in Article 1.3.

H. Spare parts list: The CONTRACTOR shall obtain from the manufacturer, a list of suggested spare parts of all items subject to wear, such as seals, packing, gaskets, nuts, bolts, washers, etc., including all spare parts to maintain the equipment in service for a period of 5 years.

I. Special shipping, storage and protection, and handling instructions

1.3 QUALITY ASSURANCE

A. The CONTRACTOR shall submit the following:

1. Manufacturer’s Certificate of Proper Installation

2. Functional Test Certification

3. Factory performance test reports

4. Certification: The CONTRACTOR shall obtain written certification from the designated single manufacturer for each gate type, addressed to the OWNER, stating that the equipment will efficiently and thoroughly perform the required functions in accordance with these Specifications and as shown, and that the designated single manufacturer accepts the CONTRACTOR’S assignment of full responsibility for coordination of all equipment, including actuators and controls, and services required for proper installation and operation. The CONTRACTOR shall submit all such certificates to the ENGINEER.

5. Guarantees, Warranties: After completion, the CONTRACTOR shall furnish to the OWNER the manufacturer's written guarantees, that the hydraulic gates will meet these specifications. The CONTRACTOR shall also furnish the manufacturer's warranties as published in its literature and as specified. A written warranty shall

be provided for all equipment specified in this section as required in accordance with the General Conditions.

B. Manufacturer's Qualifications: All gate manufacturers shall have a successful record of not less than 5 years in the manufacture of the gates indicated.

C. All manufactured items provided under this Section shall be new, of current manufacture, and shall be the products of reputable manufacturers specializing in the manufacture of such products; such manufacturers shall have had previous experience in such manufacture and shall, upon request of the ENGINEER, furnish the names of not less than 5 successful installations of its equipment of comparable nature to that offered under this contract.

1.4 MANUFACTURER'S SERVICE REPRESENTATIVE

A. Manufacturer’s Representative. In accordance with the requirements of Section 01660 – Testing and Training, a Manufacturer’s Representative shall be present at the site or classroom designated by the OWNER to provide the services and minimum person-days listed below, travel time excluded.

1. 1 person-days for installation assistance and inspection,

2. 1 person-days for functional and performance testing

3. 1 person-days for pre-startup training of OWNER’S personnel.

B. These services, and minimum person-days listed above, shall be provided for each gate type to be installed at the job site.

C. No additional compensation shall be provided for the services of the manufacturer’s service representative.

PART 2 PRODUCTS

2.1 GENERAL

A. All combinations of manufactured equipment which are provided under these Specifications shall be entirely compatible, and the CONTRACTOR and the listed manufacturer shall be responsible for the compatible and successful operation of the various components of the units conforming to specified requirements. All necessary mountings and appurtenances shall be included.

B. All gates shall have all of the features shown in the contract drawings, and in the Gate Schedule, attached to this Specification.

C. Materials of construction

1. General: All materials employed in the manufacture and installation of the hydraulic gates and actuators shall be suitable for the intended application; material not specifically called for shall be high-grade, standard commercial quality, free from all defects and imperfection that might affect the serviceability of the product for the purpose for which it is intended.

2. Nuts and Bolts: All nuts and bolts gates and supports shall be in accordance with Section 05500 – Metal Fabrications.

3. Gate Actuators: All gate actuators, regardless of type, shall be manufactured, installed, adjusted, and tested by the gate manufacturer at the manufacturer plant. All gates shall open counter-clockwise unless otherwise shown or specified.

D. Performance requirements

1. All gates shall be furnished complete with the accessories required to provide a functional system.

2. Refer to the Gate Schedule, attached to this Specification, for specific gate requirements.

3. The leakage allowance for each type of gate shall be as specified in each gate section and as required in the applicable ANSI/AWWA Standard.

E. Actuators

1. Unless otherwise indicated, gate and valve actuators shall be in accordance with Section 13446 – Electrical Operators for Valves and Gates and Section 15201 – Valve and Gate Actuators.

2. The electric actuators for all gates shall be of the same actuator manufacturer. The CONTRACTOR shall be responsible to coordinate this among the gate vendors.

3. Actuators:

a. Actuators shall be electric motor, handcrank, handwheel, or operating nut type as shown.
b. Weatherproof: Unless otherwise shown, actuators shall be weatherproof.
c. Pedestals: Actuators shall be pedestal mounted type unless otherwise shown or specified. Pedestals shall be of cast-iron or fabricated steel. The pedestal shall have an ample base or wall-bracket area to evenly distribute the load to the supporting concrete structure. Unless otherwise shown, wall-brackets for the actuator and intermediate stem guides shall be provided
d. Stem and stem covers: The operating stem shall be the rising stem type with plastic covers unless otherwise shown. Rising stem gates shall be provided with clear polycarbonate stem covers consistent with ASTM D3935/D707. Vent holes shall be provided to prevent condensation. Stems shall be equipped with position indicators.
e. Manual lifts: Removable cast iron handwheels shall have a solid rim, be smooth and free of sharp edges and have an arrow to show the direction of the opening. Geared lifts shall have directional arrows and revolving brass grips. The maximum radius of the handwheel shall be 15 inches. All manual lifts shall be furnished with a bronze stop nut to limit the downward travel of the stem and slide. Clockwise movement of the handwheel shall close the gate. Where indicated, the shaft shall terminate in a 2-inch square operating nut in lieu of the handwheel.

f. Electric motor actuators: Gates shall be provided with electric actuators in accordance with Section 13446 – Electrical Operators for Valves and Gates, and the recommendations of the gate manufacturer.
g. The center line of actuator shall be approximately 3 feet above the base of the pedestal.
h. Sluice gate hoist heads shall be cast iron. The operating nut shall be of solid bronze conforming to ASTM B 584. Roller or ball bearings shall be included for thrust. Bearings and stem shall be provided with a lubrication system.
i. Crank: The unit shall be designed for a maximum of 40 lb on the crank to operate the gate. The operating crank shall be readily removable to facilitate the use of a portable power actuator. The direction of crank rotation to open the gate shall be indicated on the lifting mechanism.

F. Frames: All sluice and slide gates shall be of the self-contained frame type, unless otherwise indicated on the contract drawings or on the gate schedule, attached to this Specification.

G. Protective Coating: The exterior surfaces and the wet interior surfaces of all ferrous gates shall be coated in accordance with Section 09900 - Paint and Coatings. The gate Manufacturer shall certify in writing that the required coating has been applied and tested in the manufacturing plant prior to shipment, in accordance with these Specifications. Flange faces of gates shall not be epoxy coated. Where surfaces have been shop painted but have been damaged during delivery, storage or assembly, or where shop coats have deteriorated, these surfaces shall be properly cleaned and retouched or repainted with matching paint.

H. Spare Parts: Where indicated, the CONTRACTOR shall furnish the required spare parts suitably packaged and labeled with the gate name, location, and identification number. The CONTRACTOR shall also furnish the name, address, and telephone number of the nearest distributor for the spare parts of each gate. All spare parts are intended for use by the OWNER, only after expiration of the guarantee period.

2.2 SLUICE GATES

A. General

1. All gates shall be new and of current manufacture. They shall be adequately braced to prevent warping and bending under the intended usage. All sluice gates features shall be in accordance with the supplemental gate schedule, attached to this Specification. Sluice gates shall be furnished with a handwheel, crank-operated or electrically operated floor stand, having a minimum 2:1 gear ratio, or 2-inch square operating nut, as shown, and shall conform to ANSI/AWWA C560, except as otherwise specified herein.

B. Performance requirements: Per ANSI/AWWA C560 the leakage allowance for sluice gates shall not exceed 0.1 gpm/ft of seating perimeter, and 0.2 gpm/ft of seating perimeter under 20 ft or less of unseating head. For unseating heads greater than 20 ft the allowable leakage shall not exceed the value calculated by the equations specified in ANSI/AWWA C560.

C. Materials of construction

1. Frames and Slides: Gate frames and slides shall be of cast iron. All gate assemblies shall be shop tested and certified by the manufacturer to meet the maximum heads shown on the supplemental gate schedule, attached to this Specification. Slides and frames shall have well-machined seating faces, and the maximum clearance between seating surfaces, with the slide in the closed position shall be 0.004 inches. Sufficient adjustable wedging shall be provided to insure a practical watertightness, as specified in ANSI/AWWA C560. Seating faces shall be of Naval bronze, to ASTM B21 and fasteners, anchor bolts, studs, and adjusting screws shall be of Type 316 stainless steel conforming to ASTM A276, or as otherwise approved. Operating nuts shall be of bronze conforming to ASTM B584.

2. Stems: Stems shall be of Type 316, Type 304, or other approved stainless steel. conforming to ASTM A276 and shall be provided with adjustable bronze bushed stem guides to ensure that the L/R ratio of the stem does not exceed 200.

3. Wall Thimbles: Unless otherwise shown, all sluice gates shall be furnished and installed with cast iron, F-pattern, wall thimbles to match the thickness of the walls in which they are installed. For walls over 12-inches thick, the minimum thickness of the wall thimble shall be 12-inches or as recommended by the gate manufacturer based on the design parameters provided on the supplemental gate schedule, attached to this Specification. Where new gates are installed on existing wall thimbles, the CONTRACTOR shall field verify bolt pattern to ensure proper fitup of the new gates with existing wall thimbles. All existing bolts shall be replaced with new 316 stainless steel bolts when an existing wall thimble is used. These thimbles shall be supplied by the manufacturer of the gates, and they shall fit the bolt dimensions of the gates. All studs shall be of Type 316 stainless steel. For gates mounted on pipe, pipe flanges shall be used unless otherwise shown.

4. Sealant: The elastomeric sealant shall be Rubber Caulk Sealer (Optional: a Butyl Rubber Acetate mastic as recommended by the manufacturer of the gates) as manufactured by Product Research Company, Los Angeles, or equal.

5. Grout: Gates mounted against concrete walls without wall thimbles shall be installed with one inch of non-shrink grout between the wall and the gate flange. The anchor bolts and nuts shall be of Type 316 stainless steel.

D. Manufacturers, or equal:

1. Rodney Hunt

2. Hydro Gate Corp.

3. Waterman Industries

2.3 SHEAR GATES

A. Materials of construction

1. Shear gates shall be of cast-iron construction with bronze seat and disc rings, and flanged frame, equipped with a minimum 3-foot handle with wall hook. All ferrous parts of the gate and frame shall be shop coated with epoxy as specified in Section 09900 - Painting and Coatings. Any mounting hardware, if required, shall be of Type 316 stainless steel.

B. Manufacturers, or equal:

1. Mueller

2. Waterman

2.4 SLIDE GATES/STOP GATES

A. GENERAL

1. All gates shall be new and of current manufacture, and adequately braced to prevent warpage and bending under the intended use. The gate slide shall be designed such that it will not deflect more than 1/1000 of the span of the gate at any point under the design head shown on the gate schedule, attached to this Specification. Where designated, gates shall be furnished with electric actuators.

2. All slide and stop gates shall be in accordance with the applicable ANSI/AWWA Standard.

3. Performance Requirements: The leakage allowance for all slide gates shall not exceed 0.1 gpm/ft of seating perimeter under the design head, seating or unseating as specified, to meet ANSI/AWWA C561, C562, C563 and C513.

4. Mounting Hardware: Mounting hardware, if required, shall be of the size and type recommended by the gate manufacturer and shall be furnished as part of the guide frame.

5. Stop gates:

a. All stop gates of a given material shall meet all of the design and construction requirements as specified for slide gates of that material, except for the lifting mechanisms which are described below.
b. Handles: Dual handles are required for all gates wider than 3 feet. Mounting hardware, if required shall be type 316 stainless steel. Lift points shall be designed for the force required to lift the gate dead weight and overcome the friction force due to a full water load. An impact of at least 50 percent shall be included. Lift points shall be attached to the gate so that there is no localized buckling or overstress.

6. Slide Gates

a. Frames: Frames shall have the following design characteristics:

1) Guide Length: Sufficient to retain at least 2/3 of gate slide when gate is in fully open position.
2) Additional Supports: Support guides as required to prevent buckling due to actuator forces using a slenderness ratio of L/R<200.

3) Yoke to Support Bench Stand Actuator: Form by 2 angles welded to gate frame. Deflection shall be less than l/360.
4) Yoke Arrangement: Capable of allowing removal of slide.
5) Gate frames shall be fitted with fixed sealing faces that surround the clear opening. The fixed sealing and sliding faces shall be ultra high molecular weight polyethylene.

b. Stems: Stems shall be of Type 316 or other approved stainless steel conforming to ASTM A276 and shall be provided with adjustable bronze bushed stem guides to ensure that the L/R ratio of the stem does not exceed 200. The stems shall have stub acme machined rolled or cut threads, double lead, finished or polished to 32 micro-inch finish or better.

c. Operating Nut: The operating nut shall be of solid bronze, ASTM B584. Operating thrust shall be taken on roller or ball bearings. All parts shall be provided with an alternate lubrication system. Operating nut threads shall match stem threads.

d. Seals: All fabricated slide gates shall be provided with resilient neoprene seals along the sides and across the top of the opening where submerged. A flush button removable neoprene seal shall be provided on the invert of all fabricated slide gates. Seat seals attached to the slide gate will not be acceptable. Seals shall be mounted such that they do not protrude into the specified opening of the gate. All slide gates will have ultra high molecular weight polymer seat seals having an intrinsic viscosity of greater than 14 by test. The seat seals shall be provided on both upstream and downstream faces of the slide and shall be mechanically locked in the gate guides, The UHMW seat seals will be shaped to provide two bearing surfaces and two sealing edges on each face of the slide. The slide will be a tight fit between the sealing edges to limit leakage.

e. Gates requiring top closure: Gates to be installed where water levels exceed the top of the slide shall be equipped with top closure. Top closure shall consist of neoprene double lip seals along the top and sides of the gate opening. These seals shall be mounted on an additional perimeter frame and shall not protrude into the waterway. Lip seal attachment shall be stainless steel fasteners and retaining strips. The perimeter frame shall not require boxing out the edges of the gate opening.

f. Wall Thimbles: Unless otherwise shown, all slide gates shall be furnished and installed with cast iron, F-pattern, wall thimbles to match the thickness of the walls in which they are installed. These thimbles shall be supplied by the manufacturer of the gates, and they shall fit the bolt dimensions of the gates.

7. Fiberglass gates:

a. All bolts, anchor bolts, washers, and supports required in connection with the plastic or fiberglass items shall be in accordance with Section 05500 – Metal Fabrications.

b. All plastic and fiberglass items shall be manufactured with the "matched die-molded method," of material suitable for potable water, and shall be certified for such use on the shop drawings. Bolts, anchor bolts, nuts, washers, and supports shall be provided for all plastic and fiberglass items in accordance with the requirements of the manufacturers of the plastic and fiberglass items. All bolts, anchor bolts, washers, and supports required in connection with the plastic or fiberglass items shall be of Type 316 stainless steel.

c. The CONTRACTOR shall furnish details, calculations, and Drawings showing the method of fabrication and verifying that the plates will withstand any normal pressures or forces exerted without buckling or otherwise being damaged.

B. STAINLESS STEEL SLIDE GATES

1. Materials of construction: Gate frame, slide and stem shall be made of type 316 stainless steel. Fasteners and anchor bolts shall also be of type 316 stainless steel.

2. The minimum diameter of the stem shall be one inch.

3. Manufacturers, or Equal:

a. Rodney Hunt Company.
b. Hydro Gate Corp.
c. Waterman Industries, Inc.

C. FIBER GLASS SLIDE GATES

1. Fiber glass slide gates shall be constructed of 1/4-inch thick (min) reinforced plastic laminate fiber glass adequately reinforced for the operating hydrostatic pressure. Reinforcing members shall consist of rigid sandwich core construction integrally-molded to provide a smooth vertical surface.

2. Stem: The gates shall be equipped with Type 316 or other approved stainless steel lift stems and bronze lift nuts, and stainless steel lift stem extensions and cast iron pedestal.

3. Guide Frames: The gates shall be furnished with concrete-wall-mounted type guide frames of proper size to allow lifting or lowering of the gates smoothly. The guide frames shall be fiber glass reinforced plastic with factory-bonded corners.

4. Slides: Gate slides shall be reinforced with stiffeners such that, at the design head, ending stress is limited to 1/5 the ultimate strength of the material and deflection is limited to 1/1000 of the gate width.

5. Manufacturers, or Equal:

a. F. B. Leopold Co. (Division of Sybron Corp.).
b. Plasti-Fab, Inc.

D. FLAP GATES

1. General: Flap gates shall prevent backflow of water though the opening or pipe. Flap Gates shall open whenever the upstream head is over 0.2 ft higher than the downstream head.

2. Materials of construction: Gate frame and cover shall be made out of cast iron (ASTM A126, Class B) or stainless steel as defined in the gate schedule. Pivot and attaching hardware shall be Type 304 or 316 stainless steel. Fasteners and anchor bolts shall also be of type 316 stainless steel. Hinges shall consist of a

stainless steel pin and shall have a UHMWPE bushing. All other materials shall be suitable for long term immersion in raw municipal wastewater.

3. Seals shall be Neoprene or EDPM.

4. Wall Thimbles: Unless otherwise shown, flap gates shall be mounted against wall thimbles with Type 316 stainless steel bolts and sealant or gaskets. The thimbles shall be of the cast iron or stainless steel F-pattern type, to match the flap gate material and the thickness of the walls in which they are installed, and they shall be supplied by the manufacturer of the gates, to match the bolt dimensions of the gates.

5. Manufacturers, or Equal:

   a. Rodney Hunt Company.
   b. Hydro Gate Corp.
   c. Waterman Industries, Inc.

PART 3 EXECUTION

3.1 DELIVERY AND STORAGE

A. A complete set of manufacturer's instructions covering storage, installation, operation, lubrication, and maintenance shall be furnished to the OWNER no later than the date the equipment is shipped. Care during storage and procedures for installation, lubrication, and startup of the equipment and motors shall be in strict conformance with the manufacturer's instructions

B. The CONTRACTOR shall prepare and load all material and articles for shipment in a manner that protects the equipment and coatings from damage in transit, shall include a packing list, and shall be responsible for and make good on any and all damage.

C. All accessories and spare parts shall be packed separately in containers plainly marked "ACCESSORIES ONLY" or "SPARE PARTS ONLY." All packing materials shall be fire retardant. A packing list, listing the contents of each container, shall be placed in a moisture proof envelope and securely fastened to the outside of the container.

3.2 INSTALLATION

A. Hydraulic gates shall be installed in accordance with the manufacturer's printed recommendations and the requirements herein, shop drawings and as shown, unless otherwise acceptable to the ENGINEER.

B. Slide gates shall be installed in accordance with the applicable AWWA standard.

C. Actuators shall be located to avoid interference with handrails and structural members.

D. Sluice gates: Just prior to setting each gate, a 1/8-inch thick layer of mastic grade polysulfide elastomeric sealant shall be applied to the back of the gate frame. After setting the gate the nuts shall be run down on the anchor bolts just far enough to make them snug and to cause the rubber sealant to begin to ooze out, but not far enough to

produce any significant stress to the frame. Any excess sealant at the edges shall be removed. The sealant shall be allowed to cure for at least 7 days, after which the anchor bolt nuts shall be tightened to their final positions. If gaskets are being used, they shall be installed over the studs in one piece, or dovetailed and cemented with a liquid-type gasket material.

E. Alignment: Equipment shall be field tested to verify proper alignment, operation as specified, and freedom from binding, scraping, or other defects. Equipment shall be secure in position and neat in appearance.

F. Lubricants: The installation work shall include furnishing the necessary oil and grease for initial operation.

G. All damage to surface coatings incurred during shipment and/ or installation shall be repaired to the satisfaction of the ENGINEER prior to installation.

H. Cleanup: After completion of the installation and testing, the CONTRACTOR shall remove all debris from the site, clean all the equipment and controls, and hand over his work in perfect operating condition.

3.3 TESTING

A. General:

1. All gate testing shall be in accordance with applicable standards of AWWA, ANSI, and ASTM.

2. Provide testing in accordance with Section 01660 -Testing and Training.

3. The CONTRACTOR shall be responsible for the coordination of the tests of each hydraulic gate with actuators, in the presence of the manufacturer's factory service representative. Any excessive leaks shall be corrected and the equipment retested until found satisfactory. Field testing will be witnessed by the ENGINEER.

B. Performance Testing: If leakage exceeds the indicated criteria, modifications and corrections shall be made under the supervision of manufacturer's representative at no additional cost to the OWNER.

3.4 SUPPLEMENTS

A. The supplements listed below, following “END OF SECTION”, are part of this Specification.

1. Gate schedule.

END OF SECTION

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GATE SCHEDULE											
Gate No.	Description	Gate Type	Gate Material	Width X Height [In],		Seat Head (At Invert) [ft]	Actuator/ Handle Type (Note 1)	Wall Mounting Type	Frame Type	Downward Opening(In)	Upward Opening(In)
				<< W x H OR DIAMETER>>				<<F-TYPE/ SURFACE MOUNT/ FLAT BACK>>	<<SELF-CONTAINED OR NON-SELF CONTAINED>>		
23-G-01-ML	Aeration Basin 3 Influent	Slide	FRP	36x36		4	Manual	Surface Mount, Flat Back, Flush Bottom	Self-Contained		36
24-G-01-ML	Aeration Basin 4 Influent	Slide	FRP	36x36		4	Manual	Surface Mount, Flat Back, Flush Bottom	Self-Contained		36
62-G-05-FEF	Chlorine Contact Tank 2A Influent	Slide	Stainless Steel	36x48		5	Motorized, Type 4A	Wall Mount	Self-Contained		48
62-G-06-FEF	Chlorine Contact Tank 2B Influent	Slide	Stainless Steel	36x48		5	Motorized Type 4A	Wall Mount	Self-Contained		48
62-G-03-FE	Chlorine Contact Tank 2A And 2B Effluent	Slide	Stainless Steel	48x48		6	Motorized Type 4A	Wall Mount	Self-Contained		48
62-G-07-FEF	Chlorine Contact Tank Drain	Shear	Cast Iron	6” Dia.		13.5	Manual	Pipe			
62-G-08-FEF	Chlorine Contact Tank 1 Influent	Slide	Stainless Steel	36x48		5	Motorized, Type 4A	Wall Mount	Self-Contained		48

Notes:

1. See 13446 for details on electric actuators and corresponding “Type”.

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SECTION 15310 – FIRE PROTECTION PIPING AND VALVES

PART 1 GENERAL

1.1 SECTION INCLUDES

A. Automatic fire sprinkler system throughout the building.

B. Riser assembly and equipment.

C. The above is intended to describe, generally, the scope of work, but shall not be considered as a limit of work to be performed under this contract. All work necessary for complete operating fire protection systems with all fixtures and equipment, as required by authorities having jurisdiction, shall be performed under this section.

1.2 REFERENCES

A. NFPA 13 - Standard for the Installation of sprinkler systems.

B. Welding Materials and Procedures: Conform to AWS D 10.9.

C. Valves: Bear UL and FM label or marking. Provide manufacturer's name and pressure rating marked on valve body.

1.3 SUBMITTALS

A. Product Data: Provide manufacturers catalogue information. Indicate valve data and ratings. Provide mill certificates from manufacturer with piping specifications.

B. Before submitting drawings to the Contra Costa County Fire Protection District for approval, submit shop drawings to the Engineer for review. Drawing shall include plans and sections showing layout of piping and layout of all heads.

C. After making corrections as indicated by Engineer, submit complete shop drawings to the Contra Costa County Fire Protection District for approval.

D. Upon receiving approval from Contra Costa County Fire Protection District, submit four copies of approved drawings bearing stamps of above agency to the Engineer for final review.

PART 2 PRODUCTS

2.1 MANUFACTURERS

A. Mechanical couplings and fittings:

1. Gruvlok.

2. Victaulic.

B. Gate, globe and check valves:

1. Victaulic.

2. Stockham.

3. Nibco.

4. United.

5. Grinnell.

6. Milwaukee.

C. Butterfly valves:

1. Demco.

2. Centerline.

3. Keystone.

4. Stockham.

5. Milwaukee

6. Victaulic.

7. Grinnell.

8. Kennedy.

D. Ball valves:

1. Apollo.

2. Walworth.

3. Stockham.

4. Milwaukee.

5. Grinnell.

2.2 PIPE

A. Interior Sprinkler Piping:

1. Sprinkler pipe shall meet ASTM A 795 or 135, and shall be UL Listed and FM Approved. All pipe shall have a Corrosion Resistance Ratio (CRR), of 1.00 or greater per the UL Listing. All piping shall be black carbon steel.

B. Exterior piping (underground):

1. Cement lined ductile iron water main.

2. P.V.C. Class 165 pressure pipe, AWWA, C900.

2.3 PIPE FITTINGS

A. General: fittings used in sprinkler systems shall meet or exceed the following standards: Cast iron threaded fittings, class 125 and 250 - ANSI B16.4, cast iron pipe flanges and flanged fittings - ANSI B16.1, malleable iron threaded fittings class 160 and 300 - ANSI B16.3, factory made wrought steel buttweld fittings - ANSI B16.9.

B. Fire department connection above ground:

1. 150 and 300 class galvanized malleable iron, screwed.

2. Underwriters' approved grooved end fittings and couplings.

C. Interior piping:

1. Cast iron, standard weight threaded fittings.

2. Grooved end fittings with mechanical couplings.

D. Exterior Piping (Underground):

1. Mechanical couplings with rubber gaskets.

2. Bell and spigot with elastomeric 'O' rings.

E. Grooved End Fittings and Couplings:

1. Fittings shall be designed for use with grooved-end pipe and couplings.

2. Couplings, fittings and grooving methods utilized in piping system shall be by the same manufacturer.

3. Materials: Malleable Iron: ASTM A47.

4. Couplings shall be mechanical type designed to engage and lock grooved pipe or fitting ends, form leak-proof joint.

5. Housings: Malleable Iron: ASTM A47.

6. Gaskets shall be elastomer material conforming to ASTM D2000 and a Product of coupling manufacturer.

7. Bolts and nuts shall be track-head or oval neck type bolts with standard hexagon nuts, and heat treated carbon steel conforming to ASTM A183.

8. Pressure Ratings: 300 p.s.i.

9. Finish: Painted.

2.4 FLASHINGS AND SLEEVES

A. Flashings for pipes through roofs:

1. Provide counter-flashing sleeves.

2. Other flashings shall be galvanized sheet metal.

B. Sleeves; of following types as required:

1. Schedule 40, galvanized steel pipe sleeves.

2. Adjustable, telescopic metal sleeves: Similar to Adjus-to-crete.

2.5 VALVES, GENERAL

A. Provide valves of same manufacturer for all similar applications. Valves to have manufacturer's name and pressure rating clearly marked on outside of body and shall be U.L. Listed indicating valves.

B. All valves controlling water supplies to fire systems shall be provided with tamper switch (see Section 15340) and permanently marked identification sign.

C. Provide valves rated not less than 175 psi water working pressure.

D. All valves controlling sprinkler systems shall be installed so as to be operable from floor level.

2.6 SPRINKLER AND FIRE PROTECTION - U.L. APPROVED

A. Bronze gate or globe valves, 2 in. and under:

1. 175 psi wwp.

2. Solid disc.

3. Screwed bonnet.

4. Threaded end.

B. Iron gate valves, 2-1/2 in. and larger:

1. 175 psi wwp.

2. Rising stem.

3. OS&Y.

4. Solid Wedge disc/rubber encapsulated disc.

5. Flanged or grooved ends.

C. Bronze check valves, 2 in. and under:

1. Class 125, swing type, teflon disc.

D. Iron check valves, 2-1/2 in. and larger:

1. 175 psi wwp.

2. Swing check.

3. Bronze mounted.

4. Composition disc.

5. Bolted cap.

6. Flanged end.

E. 5. Iron PIV gate valves, 4 in. and larger:

1. 175 psi wwp.

2. Non-rising stem for indicator post.

3. Bronze mounted.

4. Solid wedge disc/rubber encapsulated disc.

5. O-ring packing.

F. Indicator posts:

1. Vertical type for underground fire lines (with operating wrench). Stockham G-951-A.

2. Wall type, straight type, with handsheet: Stockham G-950.

G. Iron Butterfly Valves,4 in. and Larger:

1. 175 PSI WWP.

2. UL and FM approved for indoor and outdoor service.

3. 410 SS stem.

4. Aluminum bronze disc.

5. Buna-N seat and O-ring.

PART 3 EXECUTION

3.1 INSTALLATION

A. Arrangement:

1. Except for large scale details piping is diagrammatically indicated - install generally as shown.

2. Do not scale Drawings for exact location of piping.

3. Install piping to best suit field conditions and coordinate with other trades.

4. Maximize floor space and provide access to equipment in pump rooms by running suction, discharge and test lines from pumps vertically before transition to horizontal plane.

5. Do not sleeve structural members without consent of Engineer.

3.2 PIPE JOINTING

A. Unions: Provide unions or flanges to render all items in system easily removable, including:

1. Valves.

2. Pumps.

3. Backflow preventors.

B. Pipe Ends:

1. Perform pipe cutting and end preparation to result in clean ends with full inside diameter.

2. Grind and ream as necessary.

C. Threaded Joints:

1. Sealed with approved sealant compounds or teflon tape.

D. Welded Joints:

1. Welding of piping shall be done by-welders who have been qualified by recognized agency within 6 months prior to date of Contract:

2. Perform welding in accordance with provisions of latest issue of all applicable codes including:

a. AWS D10.9, Level AR-3.
b. ANSI Code for Pressure Piping.

3. Where required, peen and wheel-grind welds.

E. Grooved End Joints:

1. Perform following in accordance with manufacturer's instructions.

2. All pipe grooving and cutting shall be in accordance with manufacturer's latest published recommendations. When a mechanical grooved piping system is used, all components shall be of the same manufacturer.

3.3 FLASHING AND SLEEVES

A. Flashings: Flash and counterflash watertight all pipe penetrations of roofs and exterior walls.

B. Sleeves:

1. Through exterior concrete walls below grade, schedule 40, galvanized steel pipe sleeves.

2. Seal annular space between pipe and sleeve water tight with one of the following:

   a. Thunderline Link-Seals.
   b. Oakum sealed in with mastic.

3. Provide membrane clamps at penetrations of membranes on exterior decks or roof areas.

4. Packing through fire rated partitions: use sealant approved by authority having jurisdiction.

C. Maintain required clearance around all pipes passing through walls, floors, platforms and foundations. When required the clearance may be filled with non hardening caulking.

3.4 INSTALLATION, GENERAL

A. Install valves with stems upright or horizontal, not inverted.

B. All main control valves shall be provided with permanent identification as to portion of system controlled.

C. Provide drain valves at main shut-off valves, low points of piping and apparatus and elsewhere as required by code.

D. Locate valves to be accessible without climbing over equipment.

3.5 VALVE APPLICATIONS

1. Gate Valves: Shut-off, sectionalizing and isolation.

2. Globe and Angle Valves: System drain down.

3. Butterfly valves: May be used in systems interchangeably in place of gate valves, except in fire pump suction lines.

3.6 FIELD QUALITY CONTROL

A. Test operate valves from closed-to-open-to-closed position while valve is under test pressure.

B. Test valve bonnets for tightness.

C. Check all valves for lubricant. Service valves which do not operate smoothly with suitable lubricant before placing in operation.

END OF SECTION

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SECTION 15340 - SPRINKLER SYSTEMS

PART 1 GENERAL

1.1 SECTION INCLUDES

1. Wet-pipe sprinkler system.
2. System design, installation, and certification.
3. Fire department connections.

1.2 REFERENCES

1. NFPA 13 - Installation of Sprinkler Systems.

1.3 SYSTEM DESCRIPTION

1. System to provide coverage for entire building.
2. Classification shall be Ordinary Hazard Group II for the entire building.
3. Contractor to obtain volume and pressure of available water supply from certified water flow test data.
4. Interface system with building fire alarm system.
5. Provide fire department connection(s) with number of inlet connections as required by Authority Having Jurisdiction. Fire department location(s) shall be approved by the Authority Having Jurisdiction.
6. The above is intended to describe, generally, the scope of work but shall not be considered as a limit of work to be performed under this contract. All work necessary for a complete fire protection system, with all fixtures and equipment, shall be performed under this section.

1.4 SUBMITTALS

1. **Before submitting drawings to the Contra Costa County Fire Protection District for approval,** submit shop drawings to Engineer for review. Drawing shall include plans and sections showing layout of piping and layout of all sprinklers.
2. After making corrections as indicated by Engineer, submit complete shop drawings to the Contra Costa County Fire Protection District for approval.
3. Upon receiving approval from the Contra Costa County Fire Protection District, submit four copies of approved drawings bearing stamps of above agency to the Architect for final review.

4. Shop Drawings: Indicate hydraulic calculations, detailed pipe layout, hangers and supports, components and accessories. Indicate system controls.

5. Product Data: Provide data on sprinklers, valves, piping and specialties, including manufacturer's catalogue information. Submit performance ratings rough-in details, weights, support requirements, and piping connections.

6. Manufacturer's Certificate: Certify that system has been tested and meets or exceeds code requirements.

PART 2 PRODUCTS

2.1 MANUFACTURERS

1. Valves: See Section 15310: FIRE PROTECTION PIPING AND VALVES.

2. Piping: See Section 15310: FIRE PROTECTION PIPING AND VALVES.

3. Alarm Actuating Devices:

    1. Acme Fire Alarm Co.
    2. Edwards Co.
    3. Gamewell Co.
    4. Notifier.
    5. Potter Electric Signal Co.
    6. Potter Roemer.
    7. Victaulic.

4. Sprinklers, Alarm Valves, Deluge Valves and related items:

    1. Viking.
    2. Grinnell.
    3. Reliable.
    4. Star.
    5. Gem.
    6. Victaulic.

5. Pressure Gauges:

    1. Ashcroft.
    2. Potter Roemer Inc.
    3. Trerice.
    4. Weis.

2.2 PIPES AND FITTINGS

1. See Section 15310: FIRE PROTECTION PIPING AND VALVES.

2.3 VALVES

1. See Section 15310: FIRE PROTECTION PIPING AND VALVES.

2.4 FIRE DEPARTMENT INLET CONNECTION (FREE STANDING TYPE):

1. Cast brass angle body or red glossy polyester coated ductile iron angle body, 18 in. long polished brass seamless cover sleeve; cast brass identification base plate, cast brass pin lug plugs and chains on each pin lug swivel.
2. Two way, similar to Potter Roemer series 5760.
3. Provide appropriate lettering on plate.
4. Furnish optional polished brass trim.

2.5 DRAINS AND TEST PIPES

1. Drains:

    1. Fire department connection: auto ball drip if required.
    2. Provide valves and/or plugs as required at base of risers, on valved sections, at alarm and dry valves and at other required locations for complete drainage of systems.

    A. Inspectors Test pipes:

    1. Valved and piped to discharge through proper orifice.
    2. Provide at sprinkler connection to standpipe riser and at other required locations.

2. Pipe drain or test pipes to spill:

    1. To building exterior.

    2. Provide test pipe with sight glass, and pipe and drain to sprinkler drain riser. U.L./F.M. alarm test module similar to Victaulic testmaster may be used.

2.6 AUDIBLE ALARM:

1. Exterior audible alarm for sprinkler waterflow shall be Potter Electric weatherproof exterior sprinkler alarm select-a-strobe/horn/sign combination, SASH-120 or approved equal. Provide 120 VAC wiring in accordance the Electric Code.

2.7 PRESSURE GAUGES

1. Provide at incoming service entry point, floor control assemblies, and other required locations.

2. Similar to Potter Roemer 6240, 3-1/2 in. dia.

2.8 SPRINKLERS

1. Cast brass, fusible link spray type with 1/2 in. discharge orifice.

2. Intermediate temperature rating, except as required by NFPA 13.

3. On exposed piping provide upright or pendent sprinklers.

4. In all rooms with ceilings run piping concealed with recessed sprinklers with white finish.

5. Sprinkler Types:

    1. Recessed pendent sprinklers similar to Reliable Model G recessed, with escutcheon.
    2. Upright or pendent sprinklers similar to Reliable Model G.

2.9 SPRINKLER CABINET

1. Enameled steel with extra sprinklers and wrenches as required by NFPA 13, including for each temperature rating and type used.

2. Permanently mount on wall near main sprinkler valve, or as otherwise directed.

2.10FLOW SWITCH:

1. Red tamper proof switch housing with flow paddle. Adjustable retard setting. Two single pole, double throw micro switches to operate separate circuits, 120V. AC type similar to Potter Roemer Series 6200.

2.11TAMPER SWITCH:

1. OS&Y gate valve use: Red tamper proof cover with "J" bolt mounting. Two double pole double throw microswitches. Similar to Potter Roemer No. 6220.

2. Rising stem globe valve use: Red tamper proof cover with collar & mounting bracket. One single pole single throw microswitch. Similar to Potter Roemer No. 6221.

3. Sprinkler system valve use: Red tamper proof cover with mounting bracket and water proof cable. One single pole normally closed micro switch. Similar to Potter Roemer No. 6222.

PART 3 EXECUTION

3.1 INSTALLATION

1. Minimum cover underground piping: 30" per local codes.

2. Accurately align sprinklers in hung ceiling areas symmetrically with diffusers, grilles, lighting fixtures and ceiling tiles. Install sprinklers in the center of ceiling tiles.

3. Any sprinklers shown on the drawings are to indicate desired locations only and not to indicate actual locations quantities, coverage and code compliance.

4. The contractor is responsible to provide actual quantities and locations of sprinklers and other required devices for code compliance with Authority Having Jurisdiction.

5. All sprinkler locations, types, finishes etc. to be submitted for review by the Engineer prior to installation.

6. Contractor shall check all conditions at the site and examine all pertinent drawings before preparing working drawings.

7. Contractor shall take measurements for his own work, verify his drawings with drawings of other trades, and existing conditions and be responsible for proper installation in available space for appurtenances herein specified and/or indicated on the drawings; and shall, before making any changes secure approval of Engineer for such variations.

3.2 TESTS

1. The contractor shall perform all acceptance tests, complete the Contractor's Material and Test Certificate(s), and forward the certificates(s) to the Authority Having Jurisdiction prior to asking for approval of the installation.

2. When the Authority Having Jurisdiction desires to be present during the conduct of acceptance tests, the contractor shall give advance notification of the time and date the testing will be performed.

3. All interior wet systems subjected to system working pressure shall be hydrostatically tested at 200 psi and shall maintain that pressure without loss for 2 hours. Loss shall be determined by a drop in gauge pressure or visual leakage.

4. Portions of systems normally subjected to working pressures in excess of 150 psi shall be tested as described above at a pressure of 50 psi in excess of normal working pressure.

END OF SECTION

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SECTION 15430 - PLUMBING PIPING AND SPECIALTIES

PART 1 GENERAL

1.1 THE REQUIREMENT

A. The Contractor shall furnish and install plumbing and specialties as shown, complete and operable with electrical connections of hook-ups as specified herein and in accordance with the Contract Documents.

1.2 WORKMANSHIP AND MATERIALS

A. All work shall in strict accordance with the Uniform State Plumbing Code, and codes of the State of California, the City of Brentwood, and any other authorities having jurisdiction. The Contractor shall have required certifications and be thoroughly familiar with the local codes. The Contractor shall obtain and pay for all necessary permits.

B. Care shall be taken at all times to protect floors, stairways, and walls during the makeup, erection of piping, and placing of equipment. The Contractor shall remove all stains and repair all damage before final acceptance of the work.

C. If, during the construction of this project, the Engineer finds materials that have identifying marks removed or lack such marks completely, he may reject such items until the Contractor has furnished proof that said items conform to the Specifications. Adequacy and extent of such proof shall be determined by the Engineer.

1.3 CONTRACTOR SUBMITTALS

A. O&M Manuals: Submit O&M Manuals in accordance with Section 01340 – Shop Drawings, Product Data and Samples for the products specified below.

PART 2 PRODUCTS

2.1 GENERAL

A. Plumbing piping, fixtures, specialties, and equipment shall be as recommended by the manufacturer for the intended usage.

B. Floor drains or floor sinks shall be provided for all equipment drains. No equipment drains shall discharge to floor slabs.

C. Painting

1. All ferrous metal, except finished, galvanized and machine surfaces, shall have surfaces prepared and primed in the shop in accordance with the requirements of Section 09900 – Painting and Coatings. Prime colors shall be compatible with finish coats to be applied in the field.
2. Self contained units such as wall-mounted hose racks shall be supplied with factory applied finish coats of baked enamel.
3. All field painting shall comply with Section 09900 – Painting and Coatings.

2.2 PIPING AND FITTINGS

A. All cast iron sanitary, storm, and vent pipe and fittings shall be manufactured in accordance with and shall meet the requirements of ASTM A74 - Cast Iron Soil Pipe and Fittings. Dimensions of cast iron soil pipe and fittings shall be as given in Table 2 of ASTM A74.

B. Hub-Less cast iron soil pipe and fittings with Clamp-All Type pipe couplings, or equal, shall be used for above ground sanitary, storm, and vent piping where approved for use by local authorities. Hub-Less cast iron soil pipe and fittings shall meet CISPI Standard 301. Pipe couplings shall have Hi-Torque capacity and meet FM Standard 1680.

C. All copper pipe and fittings for potable and service water 3 inches and smaller shall be Type L medium wall hard temper copper pipe with soldered fittings.

D. Vent piping passing through the roof shall be flashed. Flashing shall extend a minimum 12 inches from the outer surface of the pipe in all directions. Flashing shall be fabricated from 4-pound lead sheet.

2.3 INSULATION

A. All piping, valves, and fittings shall be provided with insulation as shown or required by the manufacturer and in accordance with the requirements indicated.

2.4 HANGERS, SUPPORTS, AND MISCELLANEOUS METAL WORK

A. General: The Contractor shall provide all necessary hangers and supports. No perforated strap hangers and no wire supports will be permitted. Pipe supports shall be as indicated in Section 15006 – Pipe Supports.

B. Hangers supporting insulated piping shall be sized to fit the pipe plus the insulation. Insulation at support points shall be provided with metal shields to prevent damage to the insulation.

C. Spacing:

1. Pipe support spacing for steel and cast iron pipe is given in Section 15006 – Pipe Supports.

2. Copper pipe support spacing shall be not more than 6 feet between supports.

D. Rod sizes for pipe hangers shall be as recommended by the hanger manufacturer.

E. Pipe hangers used to support uninsulated copper piping shall be copper or copper plated.

F. All vertical piping shall be supported at the base with fittings made for this purpose or supported from the nearest horizontal member or floor with a riser extension pipe clamp.

G. Anchors that are installed into existing concrete shall be Grinnel Figure 117, Modern Figure 740, or equal expansion case inserts. Drill clean holes for insertion of case and patch concrete around hole as required.

H. Continuous slotted concrete inserts, if used, shall be Crawford Figure 148, Fee & Mason Figure 9000, or equal. The Contractor shall provide secondary angle supports between main inserts to handle the loads which can be properly supported by such arrangement.

I. Concrete inserts shall be as indicated in Section 15006 – Pipe Supports. All inserts shall be galvanized.

2.5 PIPE SLEEVES

A. Where pipes pass through floors, sleeves shall extend 3 inches above the finished floor. Where pipes pass through walls, sleeves shall be flush with the wall surface.

B. All sleeves shall be Schedule 40 galvanized steel pipe, one size larger than the pipe passing through, or where pipe is insulated, one size larger than the pipe plus insulation.

C. All buried or submerged pipe sleeves shall be coated by the manufacturer with a fusion bonded epoxy in accordance with the requirements of Section 09900 – Painting and Coatings.

2.6 VALVES

A. All valves shall be as indicated and shall conform to the requirements of the applicable Section(s) of these Specification.

B. The Contractor shall provide shutoff valves on cold water piping at entrances to pipe chases and other inaccessible areas and wherever indicated or required to obtain the maximum efficiency for shutoff control on the water system. Shutoff valves shall be placed on all hot and cold water connections to equipment and fixtures. Lavatory and sink stops with wheel handle shall be brass with chrome plating. Extra long barrel stops shall be used where supply piping is concealed behind partitions.

C. All valves shall open by turning counterclockwise and shall have suitable handwheels or nuts as required.

D. Provide a temperature and pressure relief valve for each water heater. Provide pressure relief valves at other locations where indicated. Relief valves shall be equipped with manual test levers. The Contractor shall provide piping to convey relief valve discharge to the nearest floor drain, the building exterior, or as approved by the Engineer.

2.7 ACCESS DOORS AND COVERS

A. Access doors, where required in ceilings for access to valves, controls, and other equipment, shall be Karp Assoc., Maspeth, N.Y., Style DSC-210, Inryco-Milcor, Milwaukee, WI, Style AT, or equal. Doors shall be of sufficient size to allow

access but shall be not less than 12 inches by 12 inches. Ceilings with lay-in acoustical tile will not require access panels. Valves and equipment located above ceiling tile shall have a 3/4-inch diameter blue plastic button with a letter "V" set in tile.

B. Floor access covers in unfinished concrete floors not exposed to chemicals shall be galvanized cast iron with a clear opening of not less than 8 inches by 8 inches, and shall be as manufactured by Alhambra Foundry Company, Model A-2015; Neenah Foundry Co., No. R-6687, or equal. In traffic or chemical areas, access covers shall be as manufactured by Alhambra Foundry Company, Model A-1240; Neenah Foundry Co., Model R-1977, or equal, with clear opening of not less than 10 inches in diameter.

2.8 ROOF DRAINS

A. Roof drains shall have galvanized cast iron drain bodies, threaded outlet, removable locking mushroom aluminum or brass stone stainers, clamping collars with integral gravel guards, receiver, deck clamp and extension sleeves where required.

B. Manufacturers, or Equal:

1. Josam Mfg. Co., Series 21500.
2. Jay R. Smith Mfg. Co., Fig. 1010.
3. Zurn Industries, Inc., Series Z-100.

2.9 FLOOR DRAINS IN CONCRETE FLOORS

A. General: Floor drains in concrete floors shall be of cast iron, in the sizes indicated, with sediment buckets. Each floor drain located on an upper floor shall have a clamping collar, with 4-lb sheet lead flashing, 12 inches minimum all around.

B. Manufacturers, or Equal:

1. Josam Mfg. Co., Series 32100 AE-81.
2. Jay R. Smith Mfg. Co., Fig. 2350.
3. Zurn Industries, Inc., Series Z-520-Y.

2.10 CLEANOUTS

A. General: All cleanouts shall be heavy plugs with tapered shoulders against caulked lead or heavy brass plugs. Where underground or concealed, cleanouts shall be brought to floor level or as indicated in the Drawings and to accessible locations with access covers and frames.

B. Manufacturers, or Equal: The following cleanouts, or equal, shall be provided:

Description	Josam Series	J. R. Smith No.	Zurn No.
Exposed Locations	58500-20	4405	Z-1440-A

Underground (finished floors)	56010/30	4143	ZN-1400-2
Walls, Concealed	58790-20	4535	ZN-1445-1-A
Traffic Areas	56070	4240	Z-1420-27

C. All clean outs shall have a minimum diameter of 3 inches.

D. Stack cleanouts shall be installed at the base of each stack. Cleanouts shall be galvanized cast iron with ABS plastic cleanout plugs.

2.11 HOSE BIBBS

A. General: All hose bibbs in exposed locations subject to freezing shall be the non-freeze type. Hose bibbs connected to a non-potable water supply shall be provided with plastic or stainless-steel warning signs as specified in Section 10400 – Identifying Device. Where indicated, hose bibbs shall be provided with vacuum breakers as furnished by Crane Co., American Standard, or equal.

B. Manufacturers, or Equal:

Fixture Type	Description
Non-freeze post-type	Exposed bronze hydrant, post-type, depth of bury as indicated on drawings or to suit local conditions; minimum 4 feet. 1. Iowa Woodward, Model Y1. 2. Zurn, Model Z13857 or Z1340 3. Josam, Model 71700.
Hose valve	Heavy-duty bronze hydrant, with composition disc, handwheel, cap and chain. Sizes 1-1/2-inch and 2-1/2 inch: 1. Murdock 2. James Jones
Hose valve	Size 1-inch, without cap and chain: 1. Murdock 2. James Jones

2.12 WALL-MOUNTED HOSE RACKS

A. The Contractor shall provide wall-mounted hose racks at locations indicated. Racks shall be all welded steel construction, of minimum 8-gage sheet steel, hot-dip galvanized after fabrication, and shall have a capacity to hold 100 feet of 3/4-inch or 1-1/2-inch hose. Where racks are located in the open, they shall be supported from two 2- by 2- by 1/4-inch galvanized steel angle posts set in a concrete base or as indicated.

2.13 HOSES AND NOZZLES

A. The Contractor shall furnish a 75 foot length of hose in the size indicated on the Drawings for each hose rack shown on the Drawings

B. Each length of hose shall be provided with male and female Chicago fittings and nozzle. Hoses shall be seamless extruded rubber with Dacron cotton exterior designed for a working pressure of at least 200 psi.

C. Nozzles shall be capable of complete shut-off and shall produce a solid straight stream and up to a 90-degree conical fog. Nozzle material shall be polished brass. Nozzles shall have rubber bumpers.

D. Nozzle Manufacturers, or Equal:

1. W. D. Allen Mfg. Co., Illinois.
2. Fire-End and Crocker Corp., New York.
3. Halprin Supply Co., Illinois.
4. Western Fire Equipment Co., California.

2.14 EMERGENCY EYEWASH/SHOWER

A. Emergency eyewash/shower units shall be provided in the Chemical Storage and Feed Areas as indicated. The units shall provide protection against freezing and overheating of water supply pipes. All exposed water supply pipes for the unit shall be insulated with molded-type pipe covering, made of fibrous glass with a minimum k-factor of 0.23 at 75 degrees F mean temperature. The insulation shall have a minimum thickness of 1 inch.

B. Manufacturers or Equal

1. Haws, Model No. 8300-FP
2. Bradley Corp., Model S19-310NN.

2.15 LIFE RINGS AND LIFE RING ENCOLSURES

A. Life rings shall be provided as indicated on the Drawings. Life rings shall be 30” diameter Coast Guard approved ring provided with at least 90’ of rope.

B. Life rings shall be provided with fiberglass enclosures designed for outdoor storage, mounted on the deck as indicated on the Drawings and as directed by the manufacturer. Enclosures shall be non-locking “T-Handle” type in safety yellow color.

C. Manufacturer of Equal

1. Cheyenne Inc., Model LRH-C

2.16 HUB DRAINS

A. Hub drains shall be of pipe of the size and material indicated on the Drawings. The hub drain shall consist of a standard flared bell-end protruding approximately 2 inches above the top of the slab. Where no slab is called for a minimum 12-inch

outside diameter, 6-inch thick concrete color with two #4 reinforcing bar hoops shall be provided.

B. Pipes discharging into the hub drain shall be securely positioned no more than 2 inches above the mouth of the hub drain opening in a location that will result in discharge of all drainage into the hub drain.

2.17 CHEMICAL INJECTOR QUILLS

A. Provide 100 psi rated (minimum) retractable quill. Provide PVC solution tube, brass adapter and packing nut material, PVC quick release couplings, stainless steel safety chain, and NPT connections.

B. Manufacturers, or equal

1. Sat-T-Flo, Model EB-125

PART 3 EXECUTION

3.1 PREPARATION

A. The Contractor shall coordinate roughing-in with provisions for wall-and floor sleeves, pipe inserts, cutting of roof and floor penetrations so that drain lines will have the required invert elevations and slopes.

3.2 OPENINGS

A. New Construction: The Contractor shall provide all necessary openings in walls, floors, and roofs for the passage of piping and plumbing equipment within and into the buildings. All openings shall be as indicated on the Contract Drawings or as required to provide passage for the plumbing work.

B. Existing Construction:

1. The Contractor shall provide all opening required in the existing construction walls, floors, and roofs for the passage of piping and plumbing equipment. All openings shall be as indicated or required for passage.
2. All openings shall be cut in a neat and orderly manner, minimizing damage to existing structures. Patching of openings shall match existing construction.
3. The Contractor shall be responsible for hangers and supporting members installed in existing masonry or structural steel as required for the proper completion of the Work.

3.3 INSTALLATION AND APPLICATION

A. The Contractor shall provide all plumbing specialties in accordance with manufacturer's printed instructions.

B. All pipe shall be arranged in a neat and orderly manner to occupy the minimum amount of space and so that the pipe will not obstruct passageways and movement of building occupants or interfere with normal operation and maintenance of any equipment.

C. All pipe shall be carefully placed and properly sloped and shall be neatly and firmly supported by hangers or supports.

D. All piping in buildings shall be as close to the ceilings or walls as possible, unless indicated otherwise.

E. Screwed joints shall be made with joint compound and be tight and leakproof. A sufficient number of brass to ferrous metal seat unions shall be placed in lines so that any pipe, valve or piece of equipment may be easily disconnected.

F. All drainage and sanitary lines shall be properly run, trapped, and be vented to conform with Code requirements. All changes in direction shall be made with "Y" branch fittings and shall be of the same size as the pipe. Changes in pipe size shall be made with reducing fittings. Minimum depth of cover shall be 3 feet.

G. Horizontal soil, drain and waste pipes shall be given a slope of at least 1/4-inch per foot, unless indicated otherwise.

H. Floor drains and cleanouts shall be installed so the tops of the drains are flush with the finished floor.

3.4 TESTING

A. General: Contractor shall make such tests as are required by the local ordinances and codes in the presence of a local governing authority inspector to show that all piping is tight, leak free and satisfactory, and shall also perform such tests as the Engineer may direct to ensure that all fixtures and equipment operate properly. The Contractor shall pay all costs in making such tests and the costs of making all changes or repairs until the Work is acceptable to the governing authorities.

B. Testing of piping shall conform to the requirements of Section 02640 – Pipeline Testing and Disinfection.

3.5 EQUIPMENT - DAMAGE AND REMOVAL

A. The Contractor’s operations shall be carried out in such a manner as to guard against damage to those portions of the structure and equipment which are to remain in the finished work. Any damage caused by the Contractor or Subcontractor through their operations, shall be repaired by the Contractor to the satisfaction of the Engineer and at no additional cost to the Owner.

3.6 DISINFECTION

A. After potable water supply lines are tested, they shall be disinfected by introducing into the line HTH solution, liquid chlorine, or chlorine solution of sufficient strength. Then the line shall be filled with water and maintained under not less than 10 pounds per square inch pressure, for not less than 48 hours, during which period all valves on the lines shall be opened and closed several times, after which it shall be flushed clean, and then tested by the Owner. This procedure shall be repeated as often as necessary until the line is pronounced

safe for use by the Owner. No cross connection between the water mains and any pipe not yet disinfected will be permitted.

B. Disinfection of piping and fixtures shall conform to the requirements of Section 02640 – Pipeline Testing and Disinfection.

END OF SECTION

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SECTION 15500 - HEATING, VENTILATING AND AIR CONDITIONING

PART 1 GENERAL

1.1 SUMMARY:

A. The responsibilities of the Contractor shall include the following systems and equipment complete, and any additional work shown on the drawings or hereinafter specified.

1. Package Unit
2. Split System Fan Coils
3. Exhaust Fans
4. Variable Speed Motor Drive (VSD)
5. Ductwork
6. Duct and Pipe Insulation
7. Vibration Isolation
8. Motors, Drives, Guards, and Starters
9. Air Distribution
10. Automatic Temperature Control
11. Test and Balance

B. The Contractor shall provide all sheet metal work as shown on the drawings or as required for the mechanical systems. Sheet metal work shall be as specified in this section.

1.2 GENERAL REQUIREMENTS:

A. Reference to Other Sections: The applicable requirements from the following sections shall form a part of the heating, ventilating and air conditioning work and the Contractor shall consult them in detail for general and specific requirements.

1. Section 15050 General Requirements Mechanical

1.3 RELATED WORK:

A. The following work will not be furnished under this section of the specifications but will be furnished by other trades.

1. Power voltage wiring and connections thereto and all power voltage conduit.
2. Openings in walls, floor, roofs.
3. Louvers in doors and building walls.

4. Concrete work.

5. Cutting, patching and furring.

6. Flashing.

7. Final painting.

8. Equipment foundation pads and platforms.

9. Condensate piping.

1.4 SHOP DRAWINGS:

A. Submit for approval, in accordance with Section 15050, six copies of fully dimensioned shop drawings for all specified equipment, controls and ductwork construction details. Manufacturer's equipment drawings are to be complete with capacity and sound level ratings as indicated in the drawings or specifications. Contractor shall also submit all manufacturer's internal wiring diagrams for electrical equipment and shall prepare other wiring diagrams showing the interlocking of the various controls and safety devices of the heating, ventilating and air conditioning systems. Submit performance curves for all fans (except propeller types and utility sets) and for all water pumps 1 HP and larger. Equipment capacity tables requiring interpolation or extrapolation are not acceptable.

B. Submit for approval, installation drawings which show exact dimensions and locations of openings required in floors, roofs and walls for ducts, air intakes and exhaust, roof exhausters, piping etc.

C. For duct and piping shop drawing development, the contractor shall obtain the most the current architectural, structural and electrical CAD files to be overlaid on to mechanical duct and piping shop drawings.

1.5 FILTERS:

A. A complete set of filters shall be supplied for use during the construction, testing and balancing period. A complete set of new filters shall be installed after testing and balancing.

1.6 EQUIPMENT START-UP:

A. Provide the services of manufacturer's factory-trained service representative to start-up air handling units and boiler. Include in start-up, testing controls, demonstration of compliance with requirements, and replacement of damaged or malfunctioning controls and equipment.

PART 2 PRODUCTS

2.1 DUCTWORK AND ACCESSORIES:

A. Supply ducts, return ducts, and exhaust ducts, plenum chambers, housing, panels, unless otherwise specified herein or on the drawings, shall be fabricated from zinc-coated (galvanized) steel sheets conforming to the latest ASTM specification A-653. Zinc-coating shall be of the "Commercial" class. Where gauge numbers of metals are

indicated or specified, they shall represent the manufacturer's standard gauge numbers, prior to galvanizing.

B. Exposed Ductwork: All exposed ductwork shall be free from dings and dents. All rectangular and round ductwork shall have Ductmate System connections. All exposed round ducts shall be spiral type duct and shall be installed so seams line up at connections to appear as a single duct run. All exposed ductwork shall be supported using threaded rods. Sheet metal straps are not acceptable. All exposed duct fittings (i.e., elbows, branch tees, etc.) shall be two gages heavier than the duct they are connected to.

C. Volume Dampers:

1. Damper blades shall be manufactured of 16 gauge sheet metal.

2. Rectangular dampers shall be opposed blade type. Frame shall be 16 gauge galvanized steel. Where dimensions of duct exceeds 18" x 12", blades shall not be over 8-inches wide. Bearings shall be provided; holes punched in ductwork to serve as bearings will not be accepted. Locking quadrant sizes shall be as follows: Up to 40 square-inches shall be 1/4-inch quadrant; up to 18" x 12" shall be 3/8-inch quadrant, and over 18" x 12" shall be 1/2-inch quadrant.

3. Round dampers up to 9-inch diameter may be installed in sheet metal spin fittings when used for balancing air distribution devices. Frames for dampers 10-inch diameter and above shall be 16 gauge galvanized steel. Dampers above 20-inch diameter shall be reinforced. Quadrant sizes shall be as follows: up to 9-inch diameter shall be 1/4-inch quadrant, 10-inch through 20-inch diameter shall be 3/8-inch quadrant, and over 20-inch diameter shall be 1/2-inch quadrant.

D. Access Doors:

1. Duct access doors to all fire dampers shall be insulated type as manufactured by Duro Dyne, Pottorf, Karp or equal. Doors shall be 24 gauge, metal, 24 gauge frame, insulation shall be 1-inch fiberglass, covered with 28 gauge metal, with loose pin hinges, and cam-lock latches. Door frame shall contain foam gasket, and a sponge rubber gasket shall be attached to back of each door frame to ensure tight seal between duct and frame. Finish shall be factory applied. Service shall be stenciled on door, e.g., "Fire Damper" in 1/2-inch letters. Size shall be 16" x 12" where space and duct size permit. On small ducts and in restricted space, 12-inch by 10-inch may be used.

2. Access doors installed in round ductwork shall be rolled plate and shall be at least 2 gauges thicker than the gauge required for the duct. Doors shall be close-fitting with foam strip gasket and a minimum of 2 quick fastening latches. Doors for ducts up to 12-inches diameter shall be provided with 2 hinges and for ducts above 12-inches diameter provide one continuous hinge.

E. Flexible Connectors: Furnish and install connections at the point where ductwork casing connects to fans, and where shown on the drawings. Connectors shall be manufactured by Duro Dyne. Indoor flexible connectors shall be Neoprene #1 0003 MFN metal fab. Outdoor flexible connectors shall be Durolon #10002 MFD metal fab. Connectors shall be securely clamped to ductwork, fans and apparatus by means of bolted metal straps.

F. Flexible Ducts:

1. Insulated low pressure flexible duct shall be a factory fabricated assembly consisting of a zinc-coated spring steel helix, non-perforated inner liner, wrapped with nominal 1½" thick fiberglass insulation. The assembly shall be sheathed in a vapor barrier jacket. The composite assembly, including insulation and vapor barrier, shall meet the Class 1 requirements of flame spread of 25 or less, smoke developed of 50 or less as set forth in NFPA bulletin No. 90-A and be labeled by Underwriters' Laboratories, Inc.

2. Flexible ducts shall be installed in a fully extended condition free of sags and kinks, using only the minimum length required to make the connection. Where horizontal support is required, flexible duct shall be suspended on 36" centers with a minimum of 3/4" wide flat banding material. All joints and connections shall be made in accordance with the recommendations of Underwriters' Laboratories, Inc. for jointing material. Connections to rigid sheet metal shall be made with minimum 1/2" wide collar positively clamped and secured with screws or other approved fastening.

3. Insulated low pressure flexible duct shall Thermaflex MKE or approved equal.

4. The R-value for the duct insulation shall be 4.2

5. Flexible ducts shall be supported at or near mid-length with 2" wide, 28 gauge steel collar attached to the structure with an approved duct hanger. Installation shall minimize sharp radius turns or offsets. The maximum length shall be 7 feet and can be used at the terminal ends only, except that flexible ducts may be used to cross seismic joints without offsets.]

2.2 INSULATION:

A. Install thermal insulation on clean, dry surfaces after testing, inspection, and approval in strict accordance with these specifications, applicable drawings and contract documents and manufacturers' recommendations. Except for materials listed below, all insulation and accessory materials are to meet NFPA requirement of flame spread not to exceed 25 and smoke developed not to exceed 50 as tested by Procedure ASTM-E-84, NFPA 225, or UL 723. Insulation shall be Manville Products Corporation or products of equal performance, subject to approval prior to installation.

1. Excepted are:

a. Flexible, closed cell, foamed plastic insulation (Armacell or approved equal) on water chilling units, copper tubing refrigerant piping, copper tubing runouts and drain lines only.
b. PVC jacketing material and factory pre-molded PVC fitting covers (Manville Zeston or approved equal).
c. 8 oz. canvas jacket on exposed ductwork and equipment only.

B. Duct Insulation: Insulate all concealed supply and return air ducts with flexible glass fiber insulation with factory applied reinforced foil-kraft facing, Manville R-series Microlite FSKL or approved equal. Thickness shall be lined with 1½" minimum thickness, density 1.0 pcf.

75°F mean temperature.

2.3 EQUIPMENT:

A. Split System Fan Coil Units:

1. Cooling Coil: 5/8-inch O.D. seamless copper tubing mechanically bonded to configurated aluminum fins with continuous fin collars and sleeved end supports. Maximum working pressure 300 psig.

2. Heating Coil: 7/16-inch O.D. copper tubes mechanically bonded to configurated aluminum fins with continuous fin collars and sleeved end supports. Maximum working shall be pressure 200 psig.

3. Condensate drain pan and safety drain pan shall have self-extinguishing polystyrene foam insulating liner. Condensate drain pan shall have an overflow connection.

4. Fan wheels shall be centrifugal type, statically and dynamically balanced.

5. Provide with factory coating on coils.

6. All motors shall have integral thermal overload protection and start at 78 percent of rated voltage. Motors shall be permanent split capacitor on high static fans.

7. Filters shall be 1-inch throw-away type. Provide filter frame with flanges for connecting a return air plenum.

8. Unit speed switch shall be mounted on the unit chassis.

9. Units shall comply with AR1 standards 441 -70 and 443-70.

10. Units shall be Carrier or Mitsubishi.

B. Package Units

1. Section Includes:

a. Package Unit
b. Refrigeration components.
c. Unit operating controls.
d. Spring Roof curb.
e. Electrical power connections.
f. Operation and maintenance service.

2. References

a. ANSI/NFPA 90A - Installation of Air Conditioning and Ventilation Systems.
b. AHRI 360 - Unitary Air-Conditioning Equipment.
c. ANSI/ASHRAE/IESNA 90.1-1999 - Energy Standard for New Buildings Except Low-Rise Residential Buildings.
d. California Administrative Code - Title 24 Establishes the minimum efficiency requirements for HVAC equipment installed in new buildings in the State of California.

3. Submittals

a. Submit drawings indicating components, dimensions, weights and loadings, required clearances, and location and size of field connections.
b. Submit product data indicating rated capacities, weights, accessories, service clearances and electrical requirements.
c. Submit manufacturer's installation instructions.

4. Operation And Maintenance Data

a. Submit operation and maintenance data.
b. Include manufacturer's descriptive literature, start-up and operating instructions, installation instructions, and maintenance procedures.

5. Handling

a. Comply with manufacturer's installation instructions for rigging, unloading, and transporting units.
b. Protect units from physical damage. Leave factory shipping covers in place until installation.

6. WARRANTY

a. Provide a full parts warranty for one year from start-up or 18 months from shipment, whichever occurs first.

7. MAINTENANCE SERVICE

a. All work on units shall be accomplished by OEM factory trained and authorized servicing technicians
b. OEM shall provide quarterly, annual, and bi-annual maintenance in compliance with or exceeding ASHRAE Standard 180-2008.
c. Include maintenance items as outlined in manufacturer's operating and maintenance data.
d. Submit copy of service call work order or report to the Owner, and include description of work performed.

8. REGULATORY REQUIREMENTS

a. Unit shall conform to cULus for construction of packaged air conditioner and shall have cULus label affixed to rooftop package.
b. In the event the unit is not cULus approved, the manufacturer shall, at his expense, provide for a field inspection by a cULus representative to verify conformance to cULus standards. If necessary, contractor shall perform required modifications to the unit to comply with cULus, as directed by the cULus representative, at no

9. SUMMARY

a. The contractor shall furnish and install packaged rooftop air conditioning unit(s) as shown and as scheduled on the contract documents. The unit(s) shall be installed in accordance with this specification and perform at the conditions specified, scheduled or as shown on the contract drawings.

10. Manufacturers

a. Manufacturer of packaged unitary rooftop products shall have had a minimum of five years successful experience in the manufacture and service support of the rooftop packages specified herein. Manufacturers with less than five years experience in the production of rooftop units of the sizes and types specified shall not be acceptable.
b. Approved Manufacturers

1) Carrier or approved equal

11. Unit performance requirements

a. Scheduled performance is based on AHRI 360 test conditions.

12. General Unit Description

a. Unit(s) furnished and installed shall be packaged units as specified on the contract documents and within these specifications. Cooling capacity ratings shall be based upon AHRI Standard 360. Unit(s) shall consist of insulated weather tight casing with compressors, air cooled condenser coil, condenser fans, evaporator coil, filters, supply and return fan motors and drives, and unit controls.
b. Provide units with factory coating on coils.
c. Unit(s) shall be single piece construction as manufactured at the factory. Site assembled sub- assemblies will not be allowed. Package units shall be constructed for installation on a roof curb providing full perimeter support under air handler section and pedestal support under condenser section.
d. Unit(s) shall be factory run tested to include the operation of all fans, compressors, heat exchangers, and control sequences.
e. Unit(s) shall have labels, decals, and/or tags to aid in the service of the unit and indicate caution areas.

13. Unit Casing

a. Cabinet: Galvanized steel, phosphatized, and finished with an air-dry paint coating durable enough to withstand a minimum of 500 consecutive-hour salt spray application in accordance with standard ASTM B 117. Structural members shall be heavy gauge with access doors and removable panels of heavy gauge steel. Roof panels shall be sloped to provide positive drainage of rain water / melting snow away from the cabinet.
b. Access Doors: Fully gasketed hinged doors with fluted knob fasteners and chained "tie-backs" to provide access to filters, heating section, return/exhaust air fan section, supply air fan section and evaporator coil section.
c. Insulation: Provide 1/2 inch thick coated fiberglass internal liner on all exterior panels in contact with the conditioned air stream.
d. Double Wall construction: The primary function of sheet metal liners is to provide a mechanical fastener for insulation and prevent the possibility of loose insulation fibers from entering the airstream. 16 gauge exterior liners are welded to 20 gauge interior liners. All interior airstream insulation will be lined, with the exception of the vertical supports, which have foil faced insulation. culus approved.

14. Air Filters

a. Air Filters: Filters shall mount integral within unit casing and be accessible via hinged access panels. Filters shall have a MERV 8 rating. Filters shall be two-inch media filters with average dust spot efficiency of 25-35 percent and an average arrestance in excess of 90 percent when tested in accordance with ASHRAE 52-76.

15. Supply Fans

a. Supply fan shall be two single width, single inlet 9-blade direct drive plenum fan. Fan blades shall be aluminum backward-inclined airfoil. Plenum fans shall be direct-driven. Entire assembly shall be completely isolated from unit and fan board by 2” deflection spring isolation. Multiple fan widths shall be available to optimize efficiency. Fan shall not require routine maintenance such as fan bearing lubrication, belt tensioning and replacement, sheave alignment, and setscrew torque checks.
b. Provide airfoil return/relief fans with fixed-pitch sheave drive assemblies. Dynamically balance all fans and the unit's running fan assembly (fan mounted on actual shaft, bearings and in scroll housing) to assure smooth operation of the fan and it's associated assembly. Balancing of the fan only shall not be acceptable.
c. Mount fan motor(s) and fan on a common base assembly and isolated from unit with 2” spring isolators. Provide thrust restraint isolation on the fan housing/fan board to assure smooth fan startup transition and operation.
d. Fan shaft shall be mounted on grease lubricated ball bearings
e. Motor shall be open drip proof. Motor shall have a standard T-frame and a minimum service factor of 1.15. All drive components shall be accessible without the use of scaffolds or ladders, to facilitate periodic maintenance checks and for operator safety.

16. Outdoor Air Section

a. Provide 100% modulating enthalpy control. Operated through the primary temperature controls to automatically utilize OA for "free" cooling. Automatically modulated return and OA dampers shall maintain proper temperature in the conditioned space. Economizer shall be equipped with an automatic lockout when the outdoor high ambient temperature is too high for proper cooling. Minimum position control shall be standard and adjustable at the Human Interface Panel or with a remote potentiometer or through the building management system. A spring return motor shall ensure closure of OA dampers during unit shutdown or power interruption. Mechanical cooling shall be available to aid the economizer mode at any ambient. Low leak economizer dampers shall be standard with a leakage rate of 2.5 percent of nominal airflow (400 CFM/ton) at 1" wg. static pressure.
b. Economizer Control with Comparative Enthalpy -Used with the fresh air economizer, two enthalpy sensors are provided to compare total heat content of the indoor air and outdoor air.
c. Provide spring-return motor for outside air damper closure during unit shutdown or power interruption.

17. Dampers

a. Leakage rate shall be determined in accordance with AMCA Standard 575.

18. Evaporator Coil Section

    a. Provide heavy duty aluminum fins mechanically bonded to copper tubes. Evaporator coil shall be inter- circuited to maintain active coil face area at part load conditions. Coil shall also utilize internally enhanced tubing for maximum efficiency.
    b. Provide a thermostatic expansion valve (TXV) for each refrigerant circuit. Factory pressure and leak test coil.
    c. Provide pitched stainless steel drain pan to assure positive drainage of condensate from the unit casint.

19. Air-Cooled Condenser Section

    a. Condenser coils shall have all Aluminum Microchannel coils. All coils shall be leak tested at the factory to ensure pressure integrity. The condenser coil is pressure tested to 650 psig. Subcooling circuit(s) shall be provided as standard.
    b. Provide subcooling circuit(s) integral with condenser coils to maximize efficiency and prevent premature flashing of liquid refrigerant, to a gaseous state, ahead of the expansion valve.
    c. Provide vertical discharge, direct drive fans with steel blades, and three phase motors. Fans shall be statically and dynamically balanced. Motors shall be permanently lubricated, with built-in current and thermal overload protection and weather tight slinger over motor bearings.
    d. Furnish unit with factory-installed electronic low ambient option to allow for operation down to 0 degrees F.
    e. Provide factory-installed louvered steel coil guards around perimeter of condensing section to protect the condenser coils, refrigerant piping and control components. Louvered panels shall be fabricated from heavy gauge galvanized steel and be rigid enough to provide permanent protection for shipping and pre-/post- installation. Course wire mesh is not an acceptable material for coil guards.

20. Refrigeration System

    a. Compressor: shall be industrial grade, energy efficient direct drive 3600 RPM maximum speed reciprocating or scroll type. The motor shall of a suction gas cooled hermetic design. Compressor shall have centrifugal oil pump with dirt separator, oil sight glass, and oil charging valve.
    b. If semi-hermetic reciprocating industrial grade compressors are utilized provide single piece crankshafts, connecting rods aluminum pistons, rings to prevent gas leakage, high strength non-flexing ring type suction and discharge valves, spring loaded heads, replaceable cylinder liners, and sealing service immersed in oil. Provide removable discharge heads and hand hole covers, and discharge service valves.
    c. Provide compressor with automatic capacity reduction equipment consisting of suction valve unloaders, Use electric solenoid actuated lifting mechanism. Provide for unloaded compressor start.
    d. Provide with thermostatic motor winding temperature control to protect against excessive motor temperatures resulting from over-/under-voltage or loss of charge. Provide high and low pressure cutouts, and reset relay.
    e. Provide factory-installed compressor lockout thermostat to prevent compressor operation at low ambient conditions.

f. Provide coil frost protection compressor unloading based on refrigerant circuit suction temperature to prevent coil frosting with minimum energy usage. As an alternate, factory-installed hot gas bypass shall be required on all VAV units to prevent coil frosting.

g. Provide a hot gas bypass valve, piping and controls are all included on circuit 2 to allow operation at low airflow, avoiding coil frosting and damage to compressor. When suction pressure falls below valve adjustable setpoint, the valve modulates hot gas to the inlet of the evaporator.

21. Ddc Microprocessor Controls

a. General - Each unit shall be provided with a factory-installed, programmed and run-tested, stand-alone, microprocessor control system suitable for VAV control as required. This system shall consist of temperature and pressure (thermistor and transducer) sensors, printed circuit boards, and a unit-mounted Control Interface Panel. The microprocessor shall be equipped with on-board diagnostics to indicate that all hardware, software, and all interconnected wiring and sensors are in proper operating condition. The microprocessor's memory shall be non-volatile EEPROM type, thus requiring no battery or capacitive backup to maintain all data during a power loss.

b. The Control Interface Panel shall be readily accessible for service diagnosis and programming without having to open the main control panel on the rooftop unit. Alphanumeric coded displays shall not be acceptable.

1) Control Interface Panel - shall be a 16 key touch-sensitive membrane key switch panel, password protected to prevent use by unauthorized personnel. The Control Interface Panel display shall consist of a 2 line by 40 characters per line clear English display. The display shall be Supertwist Liquid Crystal Display (LCD) with blue characters, 5 X 7 dot matrix with cursor, on a gray-green background for high visibility and reading ease.

c. Anti-recycle Protection - shall be provided to prevent excessive cycling, and premature wear, of the compressors, contactors and related components.

d. BACnet Communication Interface Module - Provides control and monitoring of the rooftop by Tracer SC or a 3rd party building management system utilizing BACnet protocol

22. Sound Criteria

a. Unit discharge shall not exceed the dB levels listed below.

Acoustics			
Discharge duct - 63 Hz	**97 dB**	Discharge duct - 125 Hz	**95 dB**
Discharge duct - 250 Hz	**90 dB**	Discharge duct - 500 Hz	**88 dB**
Discharge duct - 1 kHz	**85 dB**	Discharge duct - 2 kHz	**82 dB**
Discharge duct - 4 kHz	**80 dB**	Discharge duct - 8 kHz	**76 dB**
Exhaust/return/relief fan - 63 Hz	**86 dB**	Exhaust/return/relief fan - 125 Hz	**86 dB**
Exhaust/return/relief fan - 250 Hz	**81 dB**	Exhaust/return/relief fan - 500 Hz	**79 dB**
Exhaust/return/relief fan - 1 kHz	**76 dB**	Exhaust/return/relief fan - 2 kHz	**74 dB**

Exhaust/return/relief fan - 4 kHz	**71 dB**	Exhaust/return/relief fan - 8 kHz	**66 E**

23. Examination

    a. Verify that roof is ready to receive work and opening dimensions are as specified on drawings.
    b. Verify that proper power supply is available.

24. Installation

    a. Install in accordance with manufacturer's instructions.
    b. Mount units on factory built roof mounting frame providing watertight enclosure to protect ductwork. Install roof mounting curb level.

25. Manufacturer's Field Services

    a. The manufacturer shall furnish an alternative price for:
    b. Extended compressor warranty for 5 years.
    c. The manufacturer shall furnish complete submittal wiring diagrams of the package unit as applicable for field maintenance and service.

C. Variable Frequency Drives

    a. The VFD shall convert incoming fixed frequency three-phase ac power into an adjustable frequency and voltage for controlling the speed of three-phase ac motors. The motor current shall closely approximate a sine wave. Motor voltage shall be varied with frequency to maintain desired motor magnetization current suitable for the driven load and to eliminate the need for motor derating. When properly sized, the VFD shall allow the motor to produce full rated power at rated motor voltage, current, and speed without using the motor's service factor. VFDs utilizing sine weighted/coded modulation (with or without 3rd harmonic injection) must provide data verifying that the motors will not draw more than full load current during full load and full speed operation.

        1) The VFD shall include an input full-wave bridge rectifier and maintain a fundamental (displacement) power factor near unity regardless of speed or load.
        2) The VFD shall have a dual 5% impedance DC link reactor on the positive and negative rails of the dc bus to minimize power line harmonics and protect the VFD from power line transients. The chokes shall be non-saturating. Swinging chokes that do not provide full harmonic filtering throughout the entire load range are not acceptable. VFDs with saturating (non-linear) dc link reactors shall require an additional 3% AC line reactor to provide acceptable harmonic performance at full load, where harmonic performance is most critical.
        3) The VFD’s full load output current rating shall meet or exceed nec table 430-150. The VFD shall be able to provide full rated output current continuously, 110% of rated current for 60 seconds and 120% of rated torque for up to 0.5 second while starting.
        4) The VFD shall provide full motor torque at any selected frequency from 20 hz to base speed while providing a variable torque v/hz output at reduced speed. This is to allow driving direct drive fans without high

speed derating or low speed excessive magnetization, as would occur if a constant torque v/hz curve was used at reduced speeds. Breakaway current of 160% shall be available.

5) A programmable automatic energy optimization selection feature shall be provided standard in the VFD. This feature shall automatically and continuously monitor the motor's speed and load to adjust the applied voltage to maximize energy savings.
6) The VFD must be able to produce full torque at low speed to operate direct drive fans.
7) Output power circuit switching shall be able to be accomplished without interlocks or damage to the VFD.
8) An automatic motor adaptation algorithm shall measure motor stator resistance and reactance to optimize performance and efficiency. It shall not be necessary to run the motor or de-couple the motor from the load to perform the test.
9) Galvanic isolation shall be provided between the VFD's power circuitry and control circuitry to ensure operator safety and to protect connected electronic control equipment from damage caused by voltage spikes, current surges, and ground loop currents. VFDs not including either galvanic or optical isolation on both analog i/o and discrete digital i/o shall include additional isolation modules.
10) VFD shall minimize the audible motor noise through the used of an adjustable carrier frequency. The carrier frequency shall be automatically adjusted to optimize motor and VFD operation while reducing motor noise. VFDs with fixed carrier frequency are not acceptable.
11) All VFDs shall contain integral emi filters to attenuate radio frequency interference conducted to the ac power line.
12) The drive enclosure shall be standard as NEMA 12 (ip 55) and optional shall be NEMA 4X (ip 66). See schedules for project requirements.
13) Protective features
    a) A minimum of class 20 i2t electronic motor overload protection for single motor applications shall be provided. Overload protection shall automatically compensate for changes in motor speed.
    b) Protection against input transients, loss of AC line phase, output short circuit, output ground fault, over voltage, under voltage, VFD over temperature and motor over temperature. The VFD shall display all faults in plain language. Codes are not acceptable.
    c) Protect VFD from input phase loss. The VFD should be able to protect itself from damage and indicate the phase loss condition. During an input phase loss condition, the VFD shall be able to be programmed to either trip off while displaying an alarm, issue a warning while running at reduced output capacity, or issue a warning while running at full commanded speed. This function is independent of which input power phase is lost.
    d) Protect from under voltage. The VFD shall provide full rated output with an input voltage as low as 90% of the nominal. The VFD will continue to operate with reduced

output, without faulting, with an input voltage as low as 70% of the nominal voltage.

e) Protect from over voltage. The VFD shall continue to operate without faulting with a momentary input voltage as high as 130% of the nominal voltage.

f) The VFD shall incorporate a programmable motor preheat feature to keep the motor warm and prevent condensation build up in the motor when it is stopped in a damp environment by providing the motor stator with a controlled level of current.

g) VFD shall include a “signal loss detection” algorithm with adjustable time delay to sense the loss of an analog input signal. It shall also include a programmable time delay to eliminate nuisance signal loss indications. The functions after detection shall be programmable.

h) VFD shall function normally when the keypad is removed while the VFD is running. No warnings or alarms shall be issued as a result of removing the keypad.

i) VFD shall catch a rotating motor operating forward or reverse up to full speed without VFD fault or component damage.

j) Selectable over-voltage control shall be provided to protect the drive from power regenerated by the motor while maintaining control of the driven load.

k) VFD shall include current sensors on all three output phases to accurately measure motor current, protect the VFD from output short circuits, output ground faults, and act as a motor overload. If an output phase loss is detected, the VFD will trip off and identify which of the output phases is low or lost.

l) If the temperature of the VFD’s heat sink rises to 80°c, the VFD shall automatically reduce its carrier frequency to reduce the heat sink temperature. It shall also be possible to program the VFD so that it reduces its output current limit value if the VFD’s temperature becomes too high.

m) In order to ensure operation during periods of overload, it must be possible to program the VFD to automatically reduce its output current to a programmed value during periods of excessive load. This allows the VFD to continue to run the load without tripping.

n) The VFD shall have temperature controlled cooling fan(s) for quiet operation, minimized losses, and increased fan life. At low loads or low ambient temperatures, the fan(s) may be off even when the VFD is running.

o) The VFD shall store in memory the last 10 alarms. A description of the alarm, and the date and time of the alarm shall be recorded.

p) When used with a pumping system, the VFD shall be able to detect no-flow situations, dry pump conditions, and operation off the end of the pump curve. It shall be programmable to take appropriate protective action when one of the above situations is detected.

b. Internal Control Algorithm

1) Interface Features
2) Hand, off and auto keys shall be provided to start and stop the VFD and determine the source of the speed reference. It shall be possible to either disable these keys or password protect them from undesired operation.
3) There shall be an “info” key on the keypad. The info key shall include “on-line” context sensitive assistance for programming and troubleshooting.
4) The VFD shall be programmable to provide a digital output signal to indicate whether the VFD is in hand or auto mode. This is to alert the building automation system whether the VFD is being controlled locally or by the building automation system.
5) Password protected keypad with alphanumeric, graphical, backlit display can be remotely mounted. Two levels of password protection shall be provided to guard against unauthorized parameter changes.
6) All VFDs shall have the same customer interface. The keypad and display shall be identical and interchangeable for all sizes of VFDs.
7) To set up multiple VFDs, it shall be possible to upload all setup parameters to the VFD’s keypad, place that keypad on all other VFDs in turn and download the setup parameters to each VFD. To facilitate setting up VFDs of various sizes, it shall be possible to download from the keypad only size independent parameters. Keypad shall provide visual indication of copy status.
8) Display shall be programmable to communicate in multiple languages including english, spanish and french.
9) A red fault light, a yellow warning light and a green power-on light shall be provided. These indications shall be visible both on the keypad and on the VFD when the keypad is removed.
10) A quick setup menu with factory preset typical HVAC parameters shall be provided on the VFD. The VFD shall also have individual fan, pump, and compressor menus specifically designed to facilitate start-up of these applications.
11) A four-feedback PID controller to control the speed of the VFD shall be standard.
    a) This controller shall accept up to four feedback signals. It shall be programmable to compare the feedback signals to a common setpoint or to individual setpoints and to automatically select either the maximum or the feedback signal as the controlling signal. It shall also be possible to calculate the controlling feedback signal as the average of all feedback signals or the difference between a pair of feedback signals.
    b) The VFD shall be able to apply individual scaling to each feedback signal.
    c) For fan flow tracking applications, the VFD shall be able to calculate the square root of any or all individual feedback signals so that a pressure sensor can be used to measure air flow.
    d) The VFD’s PID controller shall be able to actively adjust its setpoint based on flow. This allows the VFD to compensate for a pressure feedback sensor which is located near the output of the pump rather than out in the controlled system.

e) The VFD shall have three additional PID controllers which can be used to control damper and valve positioners in the system and to provide setpoint reset.

f) Floating point control interface shall be provided to increase/decrease speed in response to contact closures.

g) Five simultaneous meter displays shall be available. They shall include at a minimum, frequency, motor current, motor voltage, VFD output power, VFD output energy, VFD temperature in degrees, among others.

h) Programmable sleep mode shall be able to stop the VFD. When its output frequency drops below set “sleep” level for a specified time, when an external contact commands that the VFD go into sleep mode, or when the VFD detects a no-flow situation, the VFD may be programmed to stop. When the VFD’s speed is being controlled by its PID controller, it shall be possible to program a “wake-up” feedback value that will cause the VFD to start. To avoid excessive starting and stopping of the driven equipment, it shall be possible to program a minimum run time before sleep mode can be initiated and a minimum sleep time for the VFD.

i) A run permissive circuit shall be provided to accept a “system ready” signal to ensure that the VFD does not start until dampers or other auxiliary equipment are in the proper state for VFD operation. The run permissive circuit shall also be capable of initiating an output “run request” signal to indicate to the external equipment that the VFD has received a request to run.

j) VFD shall be programmable to display feedback signals in appropriate units, such as inches of water column (in-wg), pressure per square inch (psi) or temperature (°f).

k) VFD shall be programmable to sense the loss of load and signal this condition via a keypad warning, relay output and/or over the serial communications bus. To ensure against nuisance indications, this feature must be based on motor torque, not current, and must include a proof timer to keep brief periods of no load from falsely triggering this indication.

c. Standard Control And Monitoring Inputs And Outputs

1) Six dedicated, programmable digital inputs shall be provided for interfacing with the systems control and safety interlock circuitry.

a) Two terminals shall be programmable to act as either as digital outputs or additional digital inputs.

b) Two programmable relay outputs, Form C 240 V AC, 2 A, shall be provided for remote indication of VFD status.

c) Each relay shall have an adjustable on delay / off delay time.

d) Two programmable analog inputs shall be provided that can be either direct-or-reverse acting.

- Each shall be independently selectable to be used with either an analog voltage or current signal.
- The maximum and minimum range of each shall be able to

be independently scalable from 0 to 10 V dc and 0 to 20 mA.

- A programmable low-pass filter for either or both of the analog inputs must be included to compensate for noise.
- The VFD shall provide front panel meter displays programmable to show the value of each analog input signal for system set-up and troubleshooting,

2) One programmable analog current output (0/4 to 20 mA) shall be provided for indication of VFD status. This output shall be programmable to show the reference or feedback signal supplied to the VFD and for VFD output frequency, current and power. It shall be possible to scale the minimum and maximum values of this output.
3) It shall be possible through serial bus communications to read the status of all analog and digital inputs of the VFD.
4) It shall be possible to command all digital and analog output through the serial communication bus.

d. Optional Control And Monitoring Inputs And Outputs

1) It shall be possible to add optional modules to the VFD in the field to expand its analog and digital inputs and outputs.
   a) These modules shall use rigid connectors to plug into the VFD's control card.
   b) The VFD shall automatically recognize the option module after it is powered up. There shall be no need to manually configure the module.
   c) Modules may include such items as:
      (1) Additional digital outputs, including relay outputs
      (2) Additional digital inputs
      (3) Additional analog outputs
      (4) Additional analog inputs, including Ni or Pt temperature sensor inputs
   d) It shall be possible through serial bus communications to control the status of all optional analog and digital outputs of the VFD.

e. Standard programmable firefighter's override mode allows a digital input to control the VFD and override all other local or remote commands. It shall be possible to program the VFD so that it will ignore most normal VFD safety circuits including motor overload. The VFD shall display firemode whenever in firefighter's override mode. Firemode shall allow selection of forward or reverse operation and the selection of a speed source or preset speed, as required to accommodate local fire codes, standards and conditions.

1) A real-time clock shall be an integral part of the VFD.
   a) It shall be possible to use this to display the current date and time on the VFD's display.
      - Ten programmable time periods, with individually selectable ON and OFF functions shall be available. The clock shall also be programmable to control start/stop functions, constant speeds, PID parameter setpoints and output relays. Is shall be possible to program unique events that occur only during normal work days, others that occur only on non-work days, and others that occur

on specific days or dates. The manufacturer shall provide free PC-based software to set up the calendar for this schedule.

- All VFD faults shall be time stamped to aid troubleshooting.
- It shall be possible to program maintenance reminders based on date and time, VFD running hours, or VFD operating hours.
- The real-time clock shall be able to time and date stamp all faults recorded in the VFD fault log.

f. The VFD shall be able to store load profile data to assist in analyzing the system demand and energy consumption over time.

1) The VFD shall include a sequential logic controller to provide advanced control interface capabilities. This shall include:
   a) Comparators for comparing VFD analog values to programmed trigger values
   b) Logic operators to combine up to three logic expressions using Boolean algebra
   c) Delay timers
   d) A 20-step programmable structure

g. The VFD shall include a cascade controller which allows the VFD to operate in closed loop set point (PID) control mode one motor at a controlled speed and control the operation of 3 additional constant speed motor starters.

1) Serial communications
   a) The VFD shall include a standard eia-485 communications port and capabilities to be connected to the following serial communication protocols at no additional cost and without a need to install any additional hardware or software in the VFD:
      - Siemens FLN
      - BACnet MS/TP
      - Carrier IVUE
      - Optional communication shall include:
      - LonWorks Free Topology (FTP)
   b) VFD shall have standard rs-485 port for direct connection of personal computer (pc) to the VFD. The manufacturer shall provide no-charge pc software to allow complete setup and access of the VFD and logs of VFD operation through the rs-485 port. It shall be possible to communicate to the VFD through this usb port without interrupting VFD communications to the building management system.
   c) The VFD shall have provisions for an optional 24 v DC back-up power interface to power the VFD's control card. This is to allow the VFD to continue to communicate to the building automation system even if power to the VFD is lost.

h. Adjustments

1) The VFD shall have a manually adjustable carrier frequency that can be adjusted in 0.5 khz increments to allow the user to select the desired operating characteristics. The VFD shall also be programmable to automatically reduce its carrier frequency to avoid tripping due to thermal loading.
    a) Four independent setups shall be provided.
    b) Four preset speeds per setup shall be provided for a total of 16.
    c) Each setup shall have two programmable ramp up and ramp down times. Acceleration and deceleration ramp times shall be adjustable over the range from 1 to 3,600 seconds.
    d) Each setup shall be programmable for a unique current limit value. If the output current from the VFD reaches this value, any further attempt to increase the current produced by the VFD will cause the VFD to reduce its output frequency to reduce the load on the VFD. If desired, it shall be possible to program a timer which will cause the VFD to trip off after a programmed time period.
    e) If the VFD trips on one of the following conditions, the VFD shall be programmable for automatic or manual reset: external interlock, under-voltage, over-voltage, current limit, over temperature, and VFD overload.
    f) The number of restart attempts shall be selectable from 0 through 20 or infinitely and the time between attempts shall be adjustable from 0 through 600 seconds.
    g) An automatic “start delay” may be selected from 0 to 120 seconds. During this delay time, the VFD shall be programmable to either apply no voltage to the motor or apply a DC braking current if desired.
    h) Four programmable critical frequency lockout ranges to prevent the VFD from operating the load at a speed that causes vibration in the driven equipment shall be provided. Semi-automatic setting of lockout ranges shall simplify the set-up.

i. Optional features

1) All optional features shall be built and mounted by VFD manufacturer. All optional features shall be UL listed by the VFD manufacturer as a complete assembly and carry a UL label.
    a) All panels shall be marked for their short circuit current rating in compliance with UL.

j. Service conditions

1) Ambient temperature, continuous, full speed, full load operation:
2) -10 to 45°C (14 to 113°F) through 125 hp @ 460 and 600 volt, through 60 hp @ 208 volt
3) -10 to 40°C (14 to 104°F) 150 hp and larger
4) 0 to 95% relative humidity, non-condensing.
5) Elevation to 3,300 feet without derating.
6) AC line voltage variation, -10 to +10% of nominal with full output.
7) No side clearance shall be required for cooling.
8) All power and control wiring shall be done from the bottom.
9) All VFDs shall be plenum rated.

2. Installation

a. Install equipment in accordance with manufacturer's instructions and all applicable codes.

1) Ensure that pump is pipe-mounted and free to float with any movement, expansion and contraction of piping system.
a) Support pump using floor mounted saddle as required.
(1) For vertical in-line pumps supported from structure, ensure no pipe strain is imposed on pump flanges.
2) Power wiring, as required, shall be the responsibility of the electrical contractor. All wiring shall be performed per manufacturers instructions and all applicable codes.
3) Control wiring for remote mounted switches and sensor/transmitters shall be the responsibility of the controls contractor. All wiring shall be performed per manufacturers instructions and all applicable codes.

3. DEMONSTRATION

a. The control package manufacturer's factory trained representative shall provide start-up of the packaged pumping system. This start-up shall include verification of proper installation, system initiation, adjustment and fine tuning. Start-up shall not be considered complete until the sequence of operation, including all alarms, has been sufficiently demonstrated to the Owner or Owner's designated representative. This jobsite visit shall occur only after all hook-ups, tie-ins, and terminations have been completed and signed-off on the manufacturer's start-up request form.
b. The pump control package manufacturer's factory trained representative shall provide on-site training for owner's personnel. This training shall fully cover maintenance and operation of all system components.

D. Exhaust Fans:

1. Roof Exhausters:

a. Fan shall be Greenheck; Loren Cook, or approved equal of size and capacity as called for on the drawings.
b. The impeller shall be sturdily constructed of aluminum or steel with rust resistant coating. It shall be accurately balanced, with backwardly inclined blades and non-overloading characteristics.
c. V-belt drive as indicated on drawings. Rubber and fabric V-belt drives with horsepower ratings 165% of connected motor. Cast-iron V-groove sheaves. Motor sheave adjustable. Full ball bearings mounted outside air steam, pre-lubricated motor. Drive and wheel assembly mounted on oil resistant rubber isolators.
d. Normal horsepower rating 110% of brake horsepower of fan. Motors outside air stream. Motor wired to approved horsepower rated disconnect switch located in motor compartment.

2. In-Line Fans:

a. Fan shall be factory assembled with square housing for in-line mounting in duct. Fans shall be Greenheck or approved equal.
b. Wheel shall be backwardly inclined centrifugal type constructed of steel or aluminum that has been statically and dynamically balanced.

c. The housing shall be constructed of formed steel, square shaped, with factory applied finish. One of the sides shall be hinged and shall support the motor and wheel assembly allowing the assembly to swing out for cleaning and inspection.
d. Drive shall be belt type. Motor shall be open drip-proof type with inherent thermal protection. Provide belt guard.
e. Ratings shall be in accordance with the appropriate A.M.C. approved test codes and procedures and bear the A.M.C.A. certified rating seal.

3. Centrifugal Exhaust Fan:

a. Centrifugal fan shall include housing, wheel, fan shaft, bearings and side support structure as a factory assembled unit. All sheet metal parts shall be cleaned, conditioned and painted with enameled primer finish prior to final assembly. A final coat of gray enamel shall be applied to all exterior surfaces after assembly.
b. Fan shall be constructed to be capable of operating over the minimum pressure class limits as specified in AMCA Standard 2408-69.
c. Precisely positioned cutoffs and aerodynamically spun inlet cones shall provide smooth air flow through the fan with minimum turbulence.
d. Wheels shall be non-power-overloading with ten deep, backwardly inclined airfoil blades. Blades shall be securely welded to the spun rim and to the hub plate. Hubs shall be close grained cast iron or, on Class III, tried after assembly and dynamically balanced. Wheels shall be keyed to the shaft in all cases.
e. Shafts shall be solid AISI C-i 040 or 1045 hot rolled steel accurately turned and polished. Close tolerances shall be maintained where the shaft makes contact with the bearings.
f. Bearings shall be heavy duty, grease lubricated, precision anti-friction ball or roller, self-aligning, pillow block type. Standard heavy duty bearings shall be selected for a minimum average life (AFBMA U-50_ in excess of 100,000 hours operation at maximum cataloged operating conditions.
g. Fan shall be tested and rated in accordance with AMCA Standard 210 and the Certified Ratings Program. They shall be licensed to bear the AMCA Certified Ratings Seal.
h. Fan shall be manufactured by Trane Co., Carrier, McQuay or approved equal.

4. Wall Exhaust Fan:

a. Sidewall exhaust fans shall be of the centrifugal direct driven type. Construction of the windband shall be of heavy gauge aluminum. Units shall be constructed so that removal of several fasteners shall allow for removal of entire power assembly and wheel for servicing or cleaning.
b. The fan wheel shall be of the backward curved, centrifugal type with a well designed inlet venturi for maximum performance. Wheels shall be statically and dynamically balanced to assure minimal noise and vibration generation. Blades, fins, inlet cone and back plate shall be fabricated from aluminum and securely joined together.
c. Motors and fan wheels shall be mounted on vibration isolators. Motors shall be isolated from the exhaust airstream. Air for cooling the motor shall be taken into the motor compartment from a location free of contaminants. Motors shall be readily accessible for maintenance.

d. All fans shall bear the AMCA Certified Performance Rating Seal for both air and sound performance.

E. Air Distribution:

1. Performance: Shall provide the required air throw and spread with no apparent drafts or excessive air movement within the air conditioned area. Any air distribution accessories required to effect these conditions shall be provided and installed by the Contractor. Grilles, registers or ceiling diffusers causing excessive air movement, drafts or objectionable noise, shall be replaced at no cost to the Owner. Paint inside of all ducts including volume dampers, etc., behind registers and diffusers with two coats flat black enamel. Air distribution shall have a factory applied color to match the ceiling finish.

2. Locations: All devices shall be installed in approximately the location indicated on the drawings but the Contractor shall verify the exact locations at the building, and with the drawings, making any minor changes as may be required and as approved by the Owner.

3. Air Distribution shall be "Titus" Manufacture of the model numbers listed, Anemostat or Krueger.

LAY-IN TYPE CEILING	
Ceiling Diffusers:	Model PCS3FW, Perforated 24 x 24 panel, Type 3 Border
Return Registers:	Model PAR3FW, Perforated 24 x 24 panel, Type 1 Border
PLASTER CEILING	
4. Ceiling Diffusers:	Model PCS3FW, Perforated, Flush Face, Surface Mount
5. Return Registers:	Model PAR3FW, Perforated, Flush Face, Surface Mount
SIDEWALL REGISTERS	
Supply:	Model 300, O.B.D., Double Deflection, Sponge Rubber Gasket
Return:	Model 350, O.B.D., Sponge Rubber Gasket
Return Grilles with Filter Frame:	Model 350 RF1, W/1" Filter Frame, Hinged Face and (Quarter Turn Fasteners) (Knurled Knob Fasteners).
Linear Diffuser:	Model FL – High Throw, Extruded Aluminum with Adjustable Air Pattern and Flow Control Vane and Concealed Self-Aligning Device For

	Return Unit Omit Vane.
Linear Sidewall Diffuser:	Model FL – Jet Throw, Extruded Aluminum with Adjustable Air Pattern and Flow Control Vane.

2.4 VIBRATION ISOLATION:

A. General Requirements:

1. Vibration isolation shall be provided for the various pieces of mechanical equipment and piping, as specified herein or as shown on the drawings. The vibration isolation system shall be installed in a manner to prevent the transmission of vibration to the structure. No rigid connections between rotating or oscillating equipment or piping and the building will be permitted.

2. The vibration isolation manufacturer shall furnish written instructions covering the installation and adjustment of all isolators. The manufacturer shall replace any isolation that has been improperly sized.

3. The Mechanical Contractor shall coordinate his work with the other trades. Contractors following him, such as plastering or electrical, shall be notified and instructed to avoid any contact with his installation that would reduce the effectiveness of the system.

4. The vibration isolation manufacturer shall make an inspection of the vibration installation, and inform the mechanical engineer in writing of any necessary corrections and/or adjustments.

5. Where called for the in specifications or on the drawings, all structural steel bases, including concrete pouring form bases, shall be designed and fabricated by the vibration isolation manufacturer. The concrete for the pouring form bases shall be by others.

6. All horizontal pipe inside mechanical equipment room shall be isolated from building structure by means of hangers with vibration isolators. Vibration isolators for hangers selected for same deflection as that of connecting equipment, but not more than 1-1/2-inches. Hangers provided with vertical adjustment of minimum 1-inch in either direction.

7. The suction and discharge sides of all pumps shall have straight flexible connectors. For non-ferrous piping, provide bronze hose covered with bronze wire braid with copper tube ends or bronze flanged ends, braze-welded to hose. For ferrous piping, provide stainless steel hose covered with stainless steel wire braid with NPT steel nipples or 150 psi ANSI flanges, welded to hose. Flexible connectors shall be as manufactured by Flexonics or approved equal.

B. Technical Requirements:

1. All isolators shall be designed or treated for resistance to corrosion. Structural steel bases shall be cleaned of welding slag and painted with a coat of red lead primer-finish composed of basic lead silico chromate. All nuts, bolts and washers shall be zinc-electroplated.

2. All mounts shall be selected to perform their function without undue stress or overloading. All isolators that are to be used with structural steel bases, as shown, shall be equipped with height-saving brackets. The bottom of the brackets shall be one-half inch (1/2") above the floor. These isolators shall have a method of leveling and, where spring isolators are used, shall have spring diameters not less than their deflected height. All springs shall be selected with a 50% overload safety factor. Multiple spring isolators will not be permitted.

3. All structural steel bases shall have minimum of four (4) points of support unless otherwise specified. Structural steel bases shall be coped and fitted or constructed using the overlap-insert method. Structural steel shall be wide-flange beams selected for a minimum of one-tenth (1/10) the longest dimension of the base, or designed for a maximum beam deflection of .005", unless otherwise specified. If the latter method is used, submittals shall include calculations showing the necessary moment of inertia. The steel bases shall have an operating clearance of one inch (1") above the floor. Where bases are used to mount pumps, the bases shall be large enough to support the pipe elbows.

C. Isolator Description:

2.5 MOTORS, DRIVES, GUARDS AND STARTERS:

A. Motors shall be built to the specifications of the National Electric Manufacturer's Association (NEMA). The motor shall be ball bearing, drip-proof, squirrel cage induction type for full voltage start, to operate at speeds not to exceed 1750 rpm except when indicated otherwise. The motors shall be Lincoln, Electro Dynamic, Sterling, or approved equivalent. Motors mounted outdoors shall have encapsulated windings and have weatherproof hood. The minimum service factor shall be 1.15.

B. Drives shall have one belt for units under S horsepower, at least 2 belts for units 5 horsepower to 25 horsepower, and 3 belts for units 25 horsepower and over. Belts shall be V-belt design sized for at least 150 percent of the motor horsepower. Motor pulleys shall be of the variable pitch up to 7-1/2 horsepower and fixed pitch type, 10 horsepower and larger. Pulleys shall be cast-iron with steel bushings. Provide additional new pulleys where required to drive fans at speeds necessary to give the indicated volumes. Belts shall be Bates, B.F. Goodrich, Goodyear or equal.

C. V-belt drives for the fans shall be properly protected by metal guards. Guards shall be made of not less than 16 gauge expanded metal 1/2-inch mesh, on an angle iron frame so as to securely close in the top, bottom and both sides of the drive. Ample allowance shall be made in guard for motor and belt adjustment. The guard shall be provided with openings so that the rpm of the fans may be obtained. Guards on equipment outside of building shall be of weatherproof design.

D. All guards shall be given a prime coat and one heavy coat of machinery gray enamel.

E. All guards shall conform to California General Industrial Safety Order Requirements.

F. Starters shall be across-the-line type or part winding type as required, with overload protection on all legs and shall be manual or magnetic where shown on the drawings. Starters shall be complete with NEMA Type I, enclosures with built-in "Hand-Off-Automatic" switch. Magnetic starters exposed to weather shall have NEMA Type 4 enclosure.

2.6 AUTOMATIC TEMPERATURE CONTROL: (CONVENTIONAL)

A. Summary: The temperature control manufacturer as described under this heading shall furnish and install a complete system of automatic controls as shown on plans and as specified hereinafter. All control equipment shall be the product of one manufacturer and shall be basically of the electric type. Control equipment shall be Honeywell, Inc. Carrier, Siemens or approved equal. The control manufacturer shall have a representative sample of local jobs to validate performance and shall have maintained a full time local service organization for at least three years.

B. Drawings and Checkout: The Temperature Control Contractor shall submit shop drawings of the entire control system to the Architect for approval before starting work. The control system shall be completely checked out, adjustment and calibrated to perform all required functions for proper operation.

C. Electrical Wiring: See paragraph 3.8 of this section.

D. Control Panels: Unitized steel control cabinets with hinged locked door and latch and armorhide oven baked finish shall be furnished and installed for enclosing controllers, with all controls adjustments inside panel, and enclosing electrical control devices where indicated on the plans. The electrical devices shall be all factory pre-wired to terminal strips.

E. Room Thermostats: Heating and cooling zero energy band thermostat shall be provided with fully adjustable deadband between heating and cooling stages, separate adjustable. Graduated scales and setting for each stage. Non-adjustable and non-removable stops to limit heating to a maximum of 73°F and cooling to a minimum setting of 75°F shall be inherent. Provide separate independent heating and cooling throttling range settings, each adjustable from 2°F to 10°F.

F. Automatic Valves: Automatic valves shall be of the three-way or two-way type as indicated on the drawings and shall be fully modulating. They shall be of the screwed or flared type as indicated, with 125 psi bronze rated bodies. Valve packing shall be Teflon type, spring loaded and shall be self-adjusting. Valve stems shall be stainless steel. The valve body construction shall be such that the portion of the valve stem which is in contact with the packing shall never come in contact with the metal portion of the valve. Valve shall be provided with linear throttling plugs.

2.7 SMOKE DETECTORS:

A. The air duct smoke detector shall be of the photoelectronic type.

B. The detector housing shall be California State Fire Marshall listed (CASFM) and UL listed per UL268A, specifically for use in air handling systems.

C. The detector shall operate at air velocities of 100’ per minute to 4,000’ per minute.

D. The detector shall be capable of local reset button or remote test switch (RTS).

E. The duct detector housing shall incorporate an airtight smoke chamber in compliance with UL268A, Standard for Smoke Detectors for Duct Applications.

F. The housing shall be capable of mounting to either rectangular or round ducts without adaptor brackets.

G. An integral filter system shall be included to reduce dust and residue effects on the detector and housing, thereby, reducing maintenance and servicing.

H. Sampling tubes shall be either be plastic or be able to be installed after the housing is mounted to the duct by passing through the duct housing.

I. The enclosure shall meet all applicable NEC and NFPA standards regarding the electrical junction boxes. Terminal connections shall be a strip and clamp method that is suitable for 12- 18 AWG wiring.

2.8 CARBON MONOXIDE DETECTION SYSTEM:

A. Carbon monoxide detection and exhaust fan control shall be by Macurco, Inc. SS1O3 and SS1O2 System or approved equal. This system shall use SS1O2 carbon monoxide (CO) to voltage transducers, that measure the level of CO and provide this information to the SS1O3 in an analog mode-voltage. The SS1O2 CO to voltage transducers shall mount in standard electrical boxes (4S) and operate on low voltage.

B. All power for the SS1O2 sensors shall be provided via unshielded four conductor cable from the SS1O3 control panel.

2.9 VARIABLE FREQUENCY MOTOR DRIVE (VFD)

A. Description: Provide enclosed variable frequency drives suitable for operation at the current, voltage, and horsepower indicated on the schedule. Conform to requirements of NEMA ICS 3.1. Variable frequency drives shall be manufactured by Yaskawa, ABB, or Danfoss.

B. Ratings

1. VFD must operate, without fault or failure, when voltage varies plus 10% or minus 15% from rating, and frequency varies plus or minus 5% from rating.

2. Service factor: 1.0

3. Starting Torque: 100% starting torque shall be available from 0.5 Hz. to 60 Hz.

4. Overload capability: 110% of rated FLA (Full Load Amps) for 60 seconds; 150% of rated FLA peak.

5. Controlled speed range of 40:1

6. The VFDs shall include EMI/RFI filters. The onboard RFI filter shall allow the entire VFD assembly to be CE Marked and the VFD shall meet product standard EN 61800-3 for the First Environment restricted. No Exceptions.

C. Design

1. VFD shall employ microprocessor based inverter logic, isolated from all power circuits.

2. VFD shall include surface mount technology with protective coating.

3. VFD shall employ a PWM (Pulse Width Modulated) power electronic system, consisting of:

   a. Input Section:

      1) VFD input power stage shall convert three-phase AC line power into a fixed DC voltage via a solid state full wave diode rectifier, with MOV (Metal Oxide Varistor) surge protection.
      2) A minimum of 5% DC bus impedance to minimize reflected current.

   b. Intermediate Section:

      1) DC bus as a supply to the VFD output Section shall maintain a fixed voltage with filtering and short circuit protection.
      2) DC bus shall be interfaced with the VFD diagnostic logic circuit, for continuous monitoring and protection of the power components.

   c. Output Section

      1) Insulated Gate Bipolar Transistors (IGBTs) shall convert DC bus voltage to variable frequency and voltage.
      2) The VFD shall employ PWM sine coded output technology to power the motor.

4. The VFD must be rated for operation at a carrier frequency of 5 kHz to satisfy the conditions for current, voltage, and horsepower as indicated on the equipment schedule.

5. VFD shall have an adjustable carrier frequency, from 1 kHz to 12.5 kHz (Above 250 HP from 1 kHz to 5 kHz)

6. VFD Must include an adjustable dynamic noise control for quiet motor operation

D. Enclosures:

1. The cabinet that houses the VF should be large enough to safely contain the VFD and its related components.

2. The cabinet that houses the VFD should be manufactured of metal and be painted with a primer and top coat combination that will provide long-term protection for the metal in the cabinet. The cabinet will be painted both inside and outside.

3. Where the cabinet is located indoors and is not exposed to moisture or hazardous conditions like acid fumes, dust, or being dripped on with water the cabinet will be certified by the manufacture and labeled as a NEMA type 12 enclosure.

4. Where the cabinet is exposed to moisture, sunlight, or outdoor air it shall be constructed to be weather resistant. This construction shall extend to the design and manufacturing of the primary access door, and the weather covers and protection of the ventilation and conduit ports that pass through the exterior wall of the cabinet. The cabinet for this application shall be rated and labeled a NEMA type 4 enclosure.

5. Enclosures that are exposed to a highly corrosive environment, fire, or explosive type hazardous conditions, or continuous 98% plus moisture environments will require another specification to describe them.

6. Emergency shut down devices shall be accessible without opening the door to the enclosure.

7. An on/off electrical circuit disconnect switch shall be provided inside the cabinet. A lever handle on the outside of the cabinet shall activate the switch to make the electrical circuit that is supplied to the VFD either 100% operable or 100% disconnected from the electrical power source. Movement of the lever handle from the 100% on position to the 100% off position shall not require more than 5 lbs of force.

E. Bypass

1. Bypass with service switch.

2. Three Contactor Manual Bypass shall be provided when indicated by the schedule. VFD and bypass package shall be fully pre-wired and ready for installation as a single UL listed device. Bypass shall include the following:

   a. Drive output, and bypass contactors to isolate the VFD from the motor, when the motor is running in the bypass mode. These contactors shall be electrically and software interlocked to ensure safe operation.
   b. 120 VAC control transformer, with fused primary.
   c. Electronic motor overload relay, to display motor amps and protect the motor while operating in the bypass mode.
   d. Disconnect switch, with a pad-lockable through-the-door handle mechanism.
   e. Control and safety circuit terminal strip.
   f. Current transformers on the output of the Drive/Bypass package for displaying motor current in both modes of operation as well as verification that the motor is running.
   g. Provide BACnet and Modbus communication protocols as standard, with the ability to configure controller parameters view controller monitors, control I/O, clear faults and view controller status in both drive and bypass modes.
   h. Door mounted control panel with; Drive/Bypass selector keys, Hand/Off/Auto selector keys, Normal/Test selector keys.
   i. Door mounted control keypad with LCD display for “Control Power”, “Drive Ready”, “Drive Run”, “Drive Selected”, “Drive Fault”, “Drivel Test”, “Bypass Selected”, “Bypass Run”, “Motor OL”, ”Safety Open” “BAS Interlock”, “Auto Run”, Auto Transfer”, “Emergency Override”, “Hand Mode”, “Off Mode”, and “Auto Mode”.
   j. Drive/Bypass selector keys, to allow switching between the Drive and Bypass mode.
   k. Hand/Off/Auto selector keys shall provide the following operation and be programmed to operate in any of these modes upon power-up:

      1) Normal/Test selector keys, to allow VFD trouble shooting while operating in bypass mode. This option is only available with the 3 contactor style bypass.
      2) Hand Position - The drive is given a start command, operation is via the local speed input (digital operator/keypad). If in bypass mode, the motor is running.

3) Off Position - The start command is removed, all speed inputs are ignored, power is still applied to the drive. If in bypass mode, the motor is stopped.
4) Auto Position - The drive is enabled to receive a start command and speed input from a building automation system. If in bypass mode, the motor start/stop is controlled by the building automation system.
5) Eight Programmable digital inputs (24Vdc, 8mA) shall be provided for Auto Transfer to bypass, Safety Interlock, BAS Interlock, and numerous other bypass specific functions.
6) Four Programmable form C relays (24Vdc/120 VAC, 2 Amp) for: “Motor Run”, “Damper Actuator”, “Auto Transfer”, “Drive Run”, “Hand Mode”, “Auto Mode”, “System Fault”, “Bypass Run” or ”Serial Com Run”.
7) Damper control circuit with end of travel feedback capability. This circuit shall also include two adjustable wait time functions. One is a run delay time where the drive will operate at a preset speed before the damper opens to pressurize the system. The other time function is an interlock wait time, so if the damper has not fully opened within the specified time, a fault will be declared.
8) Line voltage sensors to monitor for brownout, blackout and single phase conditions. Fault levels for each condition must be adjustable to ensure the proper settings pursuant to each application.
9) Selectable energy savings and harmonic reduction mode. Drive automatically switches to Bypass (Across-the-line) when motor is running 60 Hz for a set time and automatically switches back when frequency reference changes.

l. Main input circuit breaker with a pad-lockable through-the-door handle mechanism, able to achieve a SCCR panel rating of 100kAIC.
m. Engraved cabinet nameplates shall be provided.
n. Line reactors shall be provided on the input side of the drive for harmonic suppression.
o. Output reactors shall be provided on the output side of the drive for motor protection in long motor lead length situations.
p. Multiple motor operation; Two motor “OR” control; Multiple motor “AND” control shall be provided.
q. Two motor “OR” control allows local or remote motor operation selection between two individual motors (pump #1 “OR” auto “OR” pump #2).
r. Multiple motor “AND” control allows the operation of several motors from one drive (pump #1, pump #2, “AND” pump # 3 are operated at the same speed via the output from one drive).
s. Serial communication capability for Echelon LonWorks, EtherNet/IP, Apogee, Metasys N2 shall be provided.
t. Output motor protection (dv/dt) filter shall be provided to accomplish, long motor lead length solutions.
u. PC software and cable for parameter upload/download/graphing shall be provided.
v. 12-Pulse phase shifting transformer shall be provided on: 25 HP to 150 HP @ 208 VAC, 30 HP to 150 HP @ 240 VAC, and 40 HP to 500 HP @ 480 VAC models to minimize THD generated by the VFD.

1) 18-Pulse phase shifting transformer shall be provided on: 25 HP to 150 HP @ 208 VAC, 30 HP to 150 HP @ 240 VAC, and 40 HP to 500 HP @ 480 VAC models to minimize THD generated by the VFD.

F. Communication

1. BACnet

2. LON

3. Modbus

4. Dry Contact Connection

PART 3 EXECUTION

3.1 DUCTWORK:

A. Ductwork fabrication and installation shall conform to the recommendation of the latest edition of the Duct Construction Standards Metal and Flexible as published by the Sheet Metal and Air Conditioning Contractors National Association, Inc., (SMACCNA). These standards shall govern type of seams and joints, reinforcing and supports, corner closures duct hangers, elbows, turning vanes (use double vane type), tapers offsets; streamliners, branches from mains, tee connections, register grille and ceiling diffuser connections, volume dampers, access doors in ducts, fire damper installation, casings and housing. All unwrapped exposed ducts shall be cross-broken; beading will not be acceptable. Ducts that are wrapped shall be cross-broken or beaded.

B. All necessary allowances and provisions shall be made in the installation of the ducts for the structural condition of the building, and ducts shall be transformed or divided as may be required, and where necessary to do this, the required area shall be maintained. All of these changes, however, shall be approved and installed as directed by the Owner's representative. During the installation, the open ends of ducts shall be protected to prevent debris and dirt from entering same.

C. Hangers and Supports: Vertical ducts through floor slabs shall be supported on two sides by steel angles bolted to the duct and resting with ample bearing surface on the floor, ceiling, or wall to prevent vibration. Supporting angles shall be 1-½" x 1-½" x ⅛" for ducts up to 48-inches wide. In open shafts, additional structural members shall be provided to span openings for support of ducts and angles at each floor. Ducts along walls shall have support spaced not more than eight (8) feet apart.

D. Volume dampers shall be caulked in the ducts to avoid bypass. Damper blade position on all dampers shall be indicated by filing a notch in the exposed operation rode or splitter damper rod. Volume control shall be installed in all branch ducts, whether shown on drawings or not, to allow balancing of the system. Where damper frames and blades constitute an obstruction in excess of 15 percent of the duct area, the duct shall be increased in size to receive the damper.

E. All supply duct joints shall be sealed airtight with approved mastic.

F. All duct seams and joints exposed to weather shall be caulked watertight with acrylic sealant and shall have 4-inch minimum width of 6 ounce canvas pasted on with lagging adhesive.

G. Kitchen Ventilation Systems:

1. Ducts and plenums serving Type 1 hoods shall be constructed of not less than No. 16 manufacturers standard gage steel for ducts 4 square-feet and less cross section area, and No. 14 gauge for ducts over 4 square-feet cross section area.

2. All duct joints and seams shall be made with a continuous grease tight weld or braze on the external surface.

3. Ducts shall be so constructed and installed that grease will not pocket in any portion thereof and shall slope not less than one quarter inch 1/4-inch per lineal foot toward the hood or an approved grease reservoir. Where horizontal ducts exceed 75 feet in length, the slope shall be not less than 1-inch per lineal foot.

4. The duct system shall be so constructed as to permit cleaning of the entire system. Any portion, inaccessible from the entrance or discharge shall be provided with adequate cleanout openings of sufficient size and so located to effect such cleaning. Cleanout openings shall also be installed at each change of direction of the duct and be located on the sides of the duct. Cleanout openings shall be equipped with tightfitting metal doors of equal or greater thickness than the ducts, fitted with a substantial method of latching, and designed to be opened easily without the use of a tool.

H. Dishwashing machine exhaust ductwork shall be No. 304 stainless steel, minimum of No. 18 gauge, all welded. Flanged joints where necessary shall be sealed with Dow-Corning building sealant No. 780, or equal. Bracing and reinforcing shall be equal to that herein specified for rectangular galvanized sheet metal ductwork.

3.2 PIPING INSTALLATION:

A. Pipe lines above ground shall be run parallel with the lines of the building unless otherwise shown or noted on the drawings. All horizontal runs of piping shall be kept as high as possible so as to provide maximum head room. Pipe lines shall be run so as not to interfere with ducts, wires or apparatus and with approved offsets around columns, beams and other obstructions.

B. Copper Tubing: Swagging copper tubing to couple two (2) lengths together instead of using an approved solder type coupling, will not be permitted. Incompletely filled solder joints are not acceptable. Surfaces to be soldered shall be cleaned, both the inside of the fitting and the outside of the tubing with steel wool smooth and bright. In assembling copper tube system, care must be taken to establish proper grade and alignment in the system before soldering. Installations will not be approved where tube and fittings are subjected to strain in order to obtain grade or alignment. No copper drainage or vent tube shall be bent. Copper water tube may be bent providing both area and roundness are maintained. All cut tube ends shall be filed or reamed to the full original bore.

C. Solder Joints: Heating hot water and copper piping joints shall be soldered with 95-5 solder composed of 95 percent tin and 5 percent antimony of the wire type, ASTM B32. Flux used with 95-5 solder shall be as recommended by the solder manufacturer.

D. Screwed joints shall be made with oil and graphite or other approved compound. Joint compound shall be applied to male thread only, and care should be taken to prevent compound from reaching interior of pipe.

E. Unions and flanges shall be installed in the pipe lines at such locations as needed to permit the removal of fixtures, apparatus or equipment without dismantling. Unions and flanges shall not be installed in walls, ceilings, partitions or other inaccessible locations.

F. All horizontal water and air lines shall pitch to low points to provide for complete drainage of the system. Pitch, unless otherwise shown on the drawings, shall be not less than i-inch in 40-feet 0-inches. Install drain valves at low points. Air vents shall be installed at all high points and at locations where air may pocket on all water lines.

G. Separate cold lines from hot lines by a minimum of 6-inches.

H. Piping elevations shall be established prior to installation to avoid interferences with other piping and materials and equipment of other trades.

I. All pipe welding may be by either oxy-acetylene or arc method, and shall be done by approved welders, qualified in accordance with the A.S.A. Code for Welders. Welding procedures and joint quality shall strictly conform to above procedures. The Owner's representative reserves the right to require qualifying demonstrations at the Mechanical Contractor's expense of any welders assigned to the job.

J. Tee connections in welded piping shall be made with a factory fabricated butt welding tee or with Weld-O-Lets of butt, socket or threaded type. When Weld-O-Lets are used the branch connection shall be one-half the diameter of the main or less. Scarf welding or direct butt welding of side connections shall not be permitted. Tees fabricated from pipe shall not be permitted.

K. Long radius welding ells shall, wherever possible, be used in changing pipe directions of welded pipe lines. Mitered joints shall not be approved.

L. Insulating Couplings: In all cases where dissimilar metals such as connecting copper or brass to iron or steel arises, corrosion caused by galvanic action shall be avoided by insulating the connection by means of an insulating coupling or a dielectric flanged union.

M. Reducing Fittings: For proper drainage and air elimination, eccentric type fittings shall be used when decrease in pipe size is necessary. Bushings will not be permitted.

N. Flexible Pipe Connectors: Provide at suction and discharge connections to pumps and compressors as herein specified.

O. Grooved Piping:

1. Pipe shall be prepared according to the manufacturers latest published specifications, UL, FM, ULC, NFPA, ANSIIAWWA C-606 or other applicable standards.

2. Pipe ends shall be clean and free from indentations, projections, burrs, rust, or roll marks in the area from pipe end to groove.

3. Pipe shall be roll grooved without removing metal or cut grooved according to the manufacturers latest published specifications.

4. Pipe ends must be cleaned a minimum of 1” back from the pipe end to remove all coating, weld beads, rust, projections, etc. which might affect gasket seating integrity.

5. Gasket shall be of pressure responsive design verified as proper style and grade as suitable for the intended service.

6. A thin, uniform coat of non-toxic lubricant as recommended by the pipe manufacturer, shall be applied to the pipe ends around the entire circumference, the entire exterior of the gasket, the gasket lips, and the inside of the coupling housing. Complete lubrication is essential to prevent gasket pinching and to ease gasket installation and alignment.

P. Hangers and Supports:

1. Pipe hangers and supports shall be installed to allow for expansion and contraction, and placed close to fittings, valves and heavy equipment.

2. Pipe shall be supported separately, not in tiers. Trapeze hangers will be permitted where piping is grouped together at the discretion of the Owner’s representative.

3. The Contractor shall furnish and install all structural supports, anchors, platforms and hangers required for the suspension and placement of the piping required for the installation.

4. All horizontal piping hangers, rods and supports shall have provision for a minimum of 1-3/4-inches vertical adjustment for pipe alignment and shall be provided with lock nuts.

5. Piping shall be installed so as to be free from vibration, sagging or movement other than caused by heat expansion or contraction.

6. Any drilling of the structure shall be done only in such locations that will furnish adequate support as determined by the Owner’s representative.

7. Trapeze type hangers when required shall consist of a substantial horizontal angle or channel iron with suspended adjustable steel threaded rods and nuts, or a combination of 1-inch by 2-inch angles back to back with 5/8-inch spacers between to accommodate 1/2-inch U-clamps to secure individual pipes or channel strut with channel strut clamps.

8. Supports for vertical piping shall be split clamps bolted around the pipe and resting on the floor slab. Anchors shall consist of two such clamps; one above and one below the slab. Select size of clamps to exactly fit pipe size of bare pipe. Provide copper-plated clamps for copper piping system.

9. Each hanger shall include a collar or equivalent device to fit the pipe and an Underwriters’ approved clamping or bolting device for attachment to concrete inserts, steel beams or expansion shields. Sizes of hanger rods for clevis or roller type hangers shall be as listed below:

Pipe Size / Inch	Rod Size / Inch
½ - 2	⅜
2½ - 3½	½

4 - 5	⅝
6	¾
8	⅞

10. Maximum spans between hangers for straight horizontal runs of pipe shall be in compliance with the following table.

Pipe Size	Steel	Copper	Schedule 80
½”	6’ – 0”	5’ – 0”	4’ – 6”
¾”	6’ – 0”	5’ – 0”	4’ – 6”
1”	6’ – 0”	6’ – 0”	5’
1¼”	8’ – 0”	7’ – 0”	5’ – 6”
1½”	8’ – 0”	8’ – 0”	5’ – 6”
2”	10’ – 0”	8’ – 0”	6’ – 0”
2½” and larger	10’ – 0”	8’ – 0”	7’ – 0”

Additional hangers shall be provided where concentrated weights such as valves or heavy fittings occur and where changes in direction of the piping system occurs between hangers. A hanger shall be provided immediately adjacent to any change in direction of the piping.

Q. Pipe Protection Shields: Except as otherwise indicated, provide saddles or shields under piping hangers and supports, factory-fabricated, for all insulated piping. Size saddles and shields for exact fit to mate with pipe insulation. Length shall be as recommended by manufacturers to prevent crushing of insulation.

R. Pipe Sleeves and Cover Plates:

1. The Mechanical Contractor shall furnish, located and set pipe sleeves for all piping passing through masonry walls and floors.

2. Pipe passing through fire rated construction shall be metal and extend 3’0” on each side of wall.

3. Pipe sleeves shall be of schedule 40 steel pipe, properly secured in place with an allowance of approximately 1/2” clear space all around between the sleeve and the bare pipe, or insulated pipe, passing through it. Floor sleeves shall have approved anchoring lugs.

4. In unfinished areas, each floor sleeve shall project one inch above the floor. In finished areas, sleeves shall be flushed with finished floor. The space between pipe and floor sleeves shall be tightly packed with fiberglass insulation and sealed with a one part silicone rubber sealant, such as G.E. silicone construction sealant, neatly faced. Where floor penetration is through fire rated construction sealant shall be fire proof material.

5. Each wall or partition sleeve shall finish with the wall or partition. The space between pipe and sleeve shall be packed similar to the floor sleeves.

6. The Mechanical Contractor shall furnish and install chrome plated cover plates on all piping extending into finished areas of the building, through ceilings, walls and floors. The cover plates shall be of the proper size to afford complete coverage of the opening. Where pipe insulation is carried through a pipe sleeve the cover plate shall be of sufficient size to fit around the insulation.

S. Expansion Compensation of Piping: All piping shall be anchored and supported in a manner such that expansion and contraction will take place in the direction desired, and undue strains on equipment served will be prevented. Hangers used for the support of piping shall be fabricated to permit adequate adjustment after erection while still supporting the load. Supports shall be furnished and installed to carry adequately the weight of the lines and maintain proper alignment. Insulated piping shall be provided with a pipe covered protection saddle at each support. Pipe guides and anchors of approved type shall be provided at all points where necessary to keep pipes in accurate alignment, to direct the expansion movement and to prevent buckling and swaying and undue strain. Pipe guides shall be provided for alignment connected to free (unanchored) end of each expansion joint. Pipe supports shall be spaced to provide adequate support for the pipes. Pipes shall not have pockets formed in the span due to sagging of the pipe insulation valves and fittings. Pockets shall be eliminated by having the outlet of each span lower than the maximum sag.

3.3 INSULATION INSTALLATION:

A. Insulate no piping or equipment until tested and approved for tightness. All piping shall be dry when insulated.

B. Insulate the entire surface for fittings. Insulate valves up to and including bonnets.

C. Insulate strainers to permit removal of the basket without disturbing the installation of the strainer body.

D. Bevel the ends of pipe insulation adjacent to flanges to permit bolt removal. Provide a collar of sectional block insulation over the flanges and extend a minimum of 2-inches over the adjacent pipe insulation. Fasten with bands to permit easy removal.

E. For pipe hanger insulation saddles and shields, see “Piping” section of the specifications.

F. Hot water pumps shall be insulated in such a manner to permit removal of the insulation for pump inspection and repair without destroying the insulation.

G. Hot Water Piping:

1. Adhere longitudinal laps and butt straps of jacket with factory applied pressure sensitive tape system, Manville AP-T or approved equal, or stapled on 2-inch centers with monel outward clinch staples, Manville Du-All or approved equal.

2. Provide inserts of calcium silicate pipe insulation, Manville Thermo-12 or approved equal, at each pipe shield and finish to match adjoining pipe insulation.

H. Ductwork Insulation:

1. Supply Air Ductwork Above Ceiling: Secure insulation to duct with mechanical fasteners on 18-inch centers or on underside of rectangular ducts over 30-inch wide. Seal all joints, fastener penetrations and other breaks in vapor barrier with 3-inch wide strips of the same facing material adhered with vapor barrier adhesive, Manville Z-Glue or approved equal, or 3-inch wide strips of white glass fabric, Manville Duramesh Fabric No. 206 or approved equal, coated with vapor barrier mastic, Foster 30-35 or approved equal.

2. Return Air Ductwork Above Ceiling: The insulation shall be wrapped entirely around the duct with all joints lapped at least 2-inches and secured with 16 gauge galvanized wire on 12-inch centers. The insulation shall cover all surfaces including standing seams.

I. Ductwork Liner: The duct liner shall be applied with 100% coverage of approved fire resistant adhesive. On ducts over 20-inch wide or deep, the liner shall be additionally secured with mechanical fasteners on maximum 15-inch centers. Fasteners shall start within 2-inches of the leading edge of each section and within 3-inches of the leading edge of all cross joints within the duct section. All exposed edges and the leading edge of all cross joints of the liner shall be heavily coated with an approved fire resistant adhesive. The duct liner shall be cut to assure snug closing corner joints, the black surface of the liner shall face the air stream, transverse joints shall be neatly butted, and all damaged areas shall be heavily coated with an approved adhesive.

3.4 EQUIPMENT INSTALLATION:

A. The installation of the equipment specified or shown on drawing shall be strictly in accordance with the manufacturer's instruction and installation book. All recommendations of manufacturer shall be followed, required clearances maintained, and factory approval secured for each installation. All equipment shall be securely fastened to its base. All parts of the installation shall be made weatherproof. A copy of the manufacturer's installation and service manual shall be kept with each piece of equipment at all times to allow an inspector to determine if the installation meets requirements.

B. All work shall be performed by skilled mechanics under the supervision of a competent foreman and in accordance with the best standards of practice of the trade.

3.5 ROOF AND WALL PENETRATIONS:

A. All penetrations of roof and exterior walls shall be flashed watertight with lead or galvanized iron.

B. Flashing shall comply with requirements for flashing in Sheet Metal Section.

C. Pipe flashing shall be counterflashing sleeve type with 4 pound seamless lead flashing with 8-inch skirt. The joint shall be sealed with Permaseal waterproofing compound or equal.

3.6 IDENTIFICATION OF MECHANICAL EQUIPMENT:

A. Pipe:

1. All above ground piping, including concealed piping in walls and above ceiling, as well as exposed piping, shall be clearly marked with pipe marking, colored bands, and one-way direction of flow arrow. Markings shall be setmask "Snap-around" markings per ANSI A13.1956. All markers shall have 360° visibility, directional arrow and be sealed beneath a protective plastic coating. Pipe markers shall have white letters on red piping, black letters on yellow piping and black letters on green piping.

2. All pipe markings and arrows shall be installed not less than 20 feet apart and at all valve equipment locations. Markers shall be neatly applied and in exposed

areas shall be installed after final painting has been completed. Markings shall be installed so as to be visible for easy detection.

3. Equipment: Equipment shall be identified by stenciling the identification plainly (such as EF-1 as shown on equipment schedule) on the service side. Lettering to be minimum size of 1”. This applies to fans, boiler, etc.

3.7 ELECTRICAL WORK:

A. Power voltage wiring and connections thereto and all power voltage conduit shall be furnished and installed under the Electrical Division of the specifications.

B. Low voltage and line voltage control wiring and connections thereto and all low and line voltage control conduit shall be furnished and installed under the Mechanical Sections of the Specifications.

C. Relays, push button stations, control equipment, etc., shall be provided under the Mechanical Section of the specifications, except as noted on the drawings. Check drawings closely for starters that will be furnished under the Electrical Division which will be in Motor Control Panels. Magnetic motor starters, except those furnished with packaged mechanical equipment will be provided under the Mechanical Division.

D. Disconnect switches shall be furnished, installed and connected under the Electrical Division of the specification.

3.8 EARTHQUAKE RESTRAINT:

A. Provide a means to prohibit excessive motion of all mechanical equipment during an earthquake.

B. All mechanical equipment, both hanging and base mounted, shall be provided with mounting connection points of sufficient strength to resist lateral seismic forces equal to 0.5 of equipment operating weight.

3.9 SHOP PRIMING PROCEDURES:

A. Ferrous metal items, except items to be encased in concrete and areas adjacent to field welds, shall be thoroughly cleaned and prime painted.

B. Surfaces shall be cleaned free of loose mill scale, loose rust, accessible weld slag or flux deposit. Dirt and other foreign matter shall be removed by solvent.

C. After cleaning, surfaces shall be given one shop coat of prime paint applied thoroughly and evenly to dry surfaces. Surfaces inaccessible after assembly or erection shall be given an additional shop coat of a slightly different color than first coat.

D. After erection, touch up with prime paint all members where shop coat has been damaged, welds and areas adjacent to welds and field bolts.

3.10 PAINTING:

A. Condenser water piping exposed to the weather and within mechanical equipment room shall be painted in accordance with Section 09900 of the specifications.

B. Aluminized steel surfaces of boiler stack exposed to the elements shall be protected by a minimum of one base coat of primer and one finished coat of corrosion resistant paint suitable for outer jacket skin temperatures of the particular installation (such as series 4100 or 9400 as manufactured by Rust-oleum). Outer wall of type 304 or 316 stainless steel may be substituted for paint.

3.11 PRESSURE TESTING:

A. Furnish all materials, supplies, labor and power required for testing. Make preliminary tests and prove work satisfactory.

B. Notify the Owner's representative and all authorities having jurisdiction in ample time to be present for final testing of all piping. Test before insulating or concealing any piping. Repair defects disclosed by tests or, if required by the Owner's representative, replace defective work with new work without additional cost to Owner. Make tests in stages if so ordered by the Owner's representative to facilitate work of others.

C. The Contractor is responsible for work of other trades disturbed or damaged by tests and/or repair and replacement of his work, and shall cause work so disturbed or damaged to be restored to its original condition at his own expense.

D. Unless otherwise specified, all piping shall be hydrostatically tested to 150 psi for 4 hours without perceptible loss on gauge.

NOTE TO SPEC WRITER:

This specification was based up n~ nt Technologies. A less cost approach specification based upon Chem-Pro , Inc. is located at the end of this 230800 specification.

3.12 TEST AND BALANCE OF AIR AND WATER SYSTEM:

A. The Contractor shall furnish all labor, equipment and services necessary for and incidental to air and water systems testing and balancing.

B. Include an extended warranty of one year after final acceptance by Owner, during which time the Owner may request a recheck or resetting of any outlet, coil, or device listed in the test report. Provide technicians to assist in making any test or adjustment required.

C. Contractor shall at his own expense, procure the service of an independent air balance and testing agency approved by the Owner, which specializes in the balancing and testing of heating, air conditioning and ventilating systems, to balance, adjust and test all air moving equipment, air distribution systems and exhausting systems as herein specified. All instruments used by this agency shall be accurately calibrated and maintained in good working order. If requested, the test shall be conducted in the presence of the Owner and/or his representative.

D. Air balance and testing shall not begin until system has been completed and is in full working order. The Contractor shall put all heating, ventilating and air conditioning systems and equipment in full operation and shall continue the operation of same during each working day of testing and balancing. The Contractor shall submit, within fifteen (15) days after receipt of Contract, one copy of submittal data for the testing and balancing of the air conditioning, heating and ventilating systems. The air balance agency shall provide proof of having successfully completed at least five projects of similar size and scope and shall be a certified member of the Associated Air Balance

Council and/or National Environmental Balancing Bureau and/or Testing Adjusting & Balancing Bureau (TABB) unless otherwise approved.

E. Test and balance agency shall include an extended warranty of ninety (90) days after completion of test and balancing work, during which time the Owner, at his discretion, may request a recheck or resetting of any outlet, supply air fan, or exhaust fan as listed in test report. The agency shall provide technicians to assist the Engineer in making any test he may require during this period of time. Commissioning agent shall conduct “spot checks” on air distribution to verify air balancing.

F. The Air Conditioning Contractor shall award the test and balance Contract to the approved agency upon receipt of his Contract to proceed with air conditioning installation, to allow the air balance agency to schedule this work in cooperation with other trades involved and comply with the completion date.

G. Upon completion of the air conditioning system, the air balance agency shall perform the tests, compile the test data, and submit six copies of the complete test data to the Contractor for forwarding to the Owners for evaluation and approval.

H. Testing Procedure: The Contractor shall perform the testing and balancing of air and water systems in accordance with AABC National Standards for field measurement and instrumentation, Volume 1, NEBB, or TABB. All tests described in same shall be performed the same as if written herein.

I. References

1. AABC — National Standards for Total Systems Balance

2. ADC — Test Code for Grilles, Registers, and Diffusers.

3. ASHRAE 111 — Practices for Measurement, Testing, Adjusting, and Balancing of Building Heating, Ventilation, Air Conditioning, and Refrigeration Systems.

4. NEBB — Procedural Standards for Testing, Adjusting, and Balancing.

5. SMACNA — HVAC Systems Testing, Adjusting, and Balancing.

6. TABB — International Standards for Environmental Systems Balance.

J. Submittals

1. Submit name of testing, adjusting, and balancing agency for approval within 30 days after award of contract.

2. Field Reports: Indicate deficiencies in systems that would prevent proper testing, adjusting, and balancing of systems and equipment to achieve specified performance.

3. Submit draft copies of report for review prior to final acceptance of project. Provide final copies for architect/engineer and for inclusion in operating and maintenance manuals.

4. Provide reports in soft cover, letter size, binder manuals, and complete with index page and indexing tabs with cover identification at front and side. Include set of

reduced drawings with air outlets and equipment identified to correspond with data sheets and indicating thermostat locations.

K. Quality Assurance

1. Perform total system balance in accordance with AABC National Standards for Field Measurement and Instrumentation, Total System Balance, or NEBB Standards — Procedural Standards for Testing, Adjusting, and Balancing or Environmental Systems or Testing, Adjusting, and Balancing Bureau (TABB) — National Standards for Environmental Systems Balance.

2. Maintain one copy of applicable standards on site.

L. Qualifications

1. Agency: Company specializing in the testing, adjusting, and balancing of systems specified in this section with a minimum of 3 years of experience.

M. Products

1. Replacement of adjustable pulleys, additional balancing dampers, additional fan belts, pressure taps, and fitting, hydronic balancing valves and any other devices or equipment required to effect proper testing, adjusting, and balancing shall be provided by the Contractor at no additional cost to the Owner.

N. Execution

1. Examination: Verify systems are complete and operable before commencing work. Ensure the following conditions:

   a. Systems are started and operating in a safe and normal condition.
   b. Temperature control systems are installed complete and operable.
   c. Proper thermal overload protection is in place for electrical equipment.
   d. Final filters are clean and in place. If required, install temporary media in addition to final filters.
   e. Duct systems are clean of debris.
   f. Fans are rotating correctly.
   g. Fire and volume dampers are in place and open.
   h. Air coil fins are cleaned and combed.
   i. Access doors are closed and duct end caps are in place.
   j. Air outlets are installed and connected.
   k. Duct system leakage is minimized. Duct systems having more than 25% duct surface area in unconditioned or indirectly conditioned spaces shall be sealed with leakage not greater than 6% of fan airflow, confirmed through diagnostic testing and field verification.
   l. Service and balance valves are open.

2. Submit field reports. Report defects and deficiencies noted during performance of services, which prevent system balance.

3. Beginning of work means acceptance of existing conditions.

O. Installation Tolerances

1. Air Handling Systems: Adjust to within plus or minus 6 percent of design for supply systems and plus or minus 10 percent of design for return and exhaust systems.

2. Air Outlets and Inlets: Adjust total to within plus 6 percent and minus 10 percent of design to space. Adjust outlets and inlets in space to within plus or minus 10 percent of design.

P. Adjusting — General

1. Ensure recorded data represents actual measured or observed conditions.

2. Permanently mark setting of valves, dampers, and other adjustment devices allowing setting to be restored. Set and lock memory stops.

3. After adjustment take measurement to verify balance has not been disrupted or that such disruption has been rectified.

4. Leave systems in proper working order, replacing belt guards, closing access doors, closing doors to electrical switch boxes, and restoring thermostats to specified settings.

5. At final inspection, recheck random selections of data recorded in report. Recheck points or areas as selected and witnessed by the Owner.

6. Check and adjust systems approximately 6 months after final acceptance and submit report.

Q. Air Systems Procedure

1. Test and adjust fan RPM to design requirements.

2. Test and record motor full load nameplate rating and actual ampere draw.

3. Test and record system static pressures, fan suction, and discharge.

4. Adjust all main supply and return duct to properly design CFM.

5. Test and adjust each diffuser, grille, and register. Reading and tests of diffusers, grilles, and registers shall include design velocity FPM and as adjusted velocity design CFM and adjusted CFM.

6. Test and record outside, mixed air, and discharge temperatures (db for heating cycle, db and wb for cooling cycle).

7. In coordination with the ATC Contractor, set adjustments of automatically operated dampers to operate as specified, indicated and/or noted.

8. Test and adjust air handling and distribution systems to provide required or design supply, return, outside and exhaust air quantities.

9. Make air quantity measurements in ducts by Pitot tube traverse of entire cross-sectional area of duct.

10. Measure air quantities at air inlets and outlets.

11. Adjust distribution system to obtain uniform space temperatures free from objectionable drafts and noise.

12. Use volume control devices to regulate air quantities only to extend that adjustments do not create objectionable air motion or sound levels. Effect volume control by duct internal devices such as dampers and splitters.

13. Vary total system air quantities by adjustment of fan speeds. Provide drive changes required. Vary branch air quantities by damper regulation.

14. Provide system schematic with required and actual air quantities recorded at each outlet or inlet.

15. Measure static air pressure conditions on air supply units, including filter and coil pressure drops, and total pressure across the fan. Make allowances for 50 percent loading of filters.

16. Adjust outside air automatic dampers, outside air, return air, and exhaust dampers for design conditions.

17. Measure temperature conditions across air, return air, and exhaust dampers to check leakage.

18. Where modulating dampers are provided, take measurement and balance at extreme conditions.

19. Measure and record pressure differentials between designated spaces such as operating rooms, sterilizer rooms, medical gas tank rooms, red bag storage rooms, etc.

R. Required Reports To Be Submitted

1. Report Forms

a. Title Page

1) Name of Testing, Adjusting, and Balancing Agency
2) Address of Testing, Adjusting, and Balancing Agency
3) Telephone Number of Testing, Adjusting, and Balancing Agency
4) Project Name
5) Project Location
6) Project Architect
7) Project Engineer
8) Project Contractor
9) Project Altitude
10) Report Date

b. Summary Comments

1) Design Versus Final Performance
2) Notable Characteristics of System
3) Description of System Operation Sequence

4) Summary of Outdoor and Exhaust Flows to indicate of Building Pressurization
5) Nomenclature used Throughout the Report
6) Test Conditions

c. Instrument List

1) Instrument
2) Manufacturer
3) Model Number
4) Serial Number
5) Range
6) Calibration Date

d. Electric Motors

1) Manufacturer
2) Model/Frame
3) HP/BHP
4) Phase, Voltage, Amperage, Nameplate, Actual, No Load
5) RPM
6) Service Factor
7) Starter Size, Rating, Heater Elements
8) Sheave Make/Size/Bore

e. V-Belt Drive

1) Identification/Location
2) Required Driven RPM
3) Driven Sheave, Diameter, and RPM
4) Belt, Size, and Quantity
5) Motor Sheave Diameter and RPM
6) Center to Center Distance, Maximum, Minimum, and Actual

f. Exhaust Fan Data

1) Location
2) Manufacturer
3) Model Number
4) Serial Number
5) Airflow, Specified, and Actual
6) Total Static Pressure (Total External) Specified, and Actual
7) Inlet Pressure
8) Discharge Pressure
9) Sheave Make/Size/Bore
10) Number of Belts/Make/Size
11) Fan RPM

g. Duct Traverse

1) System Zone/Branch
2) Duct Size
3) Area
4) Design Velocity
5) Design Airflow
6) Test Velocity
7) Test Airflow
8) Duct Static Pressure
9) Air Temperature

10) Air Correction Factor
11) Manufacturer
12) Airflow, Design, and Actual
13) Water Flow, Design, and Actual
14) Water Pressure Drop, Design, and Actual
15) Entering Water Temperature, Design, and Actual
16) Leaving Water Temperature, Design, and Actual
17) Entering Air Temperature, Design, and Actual
18) Leaving Air Temperature, Design, and Actual
19) Air pressure Drop, Design, and Actual

h. Air Moving Equipment

1) Location
2) Manufacturer
3) Model Number
4) Serial Number
5) Arrangement/Class/Discharge
6) Airflow, Specified, and Actual
7) Return Airflow, Specified, and Actual
8) Outside Airflow, Specified, and Actual
9) Total Static Pressure (Total External) Specified, and Actual
10) Inlet Pressure
11) Discharge Pressure
12) Sheave Make/Size/Bore
13) Number of Belts/Make/Size
14) Fan RPM

i. Return Air/Outside Air Data

1) Identification/Location
2) Design Airflow
3) Design Return Airflow
4) Actual Return Airflow
5) Design Outside Airflow

j. Air Distribution Test Sheet

1) Air Terminal Number
2) Room Number/Location
3) Terminal Type
4) Terminal Size
5) Area Factor
6) Design Velocity
7) Design Airflow
8) Test (Final) Velocity
9) Test (Final) Airflow
10) Percent of Design Airflow

2. Air Heating and Cooling Equipment:

a. Design Data:

1) Load in B.t.u.h or MBH
2) Entering and Leaving Water Temperature
3) Entering and Leaving Air Conditions (D.B. and W.B.)
4) C.F.M.
5) Water Pressure Drop

b. Recorded Data:

1) Type of Equipment and Identification (Location or number designation)
2) Entering and Leaving Air Conditions (D.B. and W.B.)
3) Entering and Leaving Water Temperatures
4) G.P.M. (if metered)
5) Temperature Rise or Drop

3.13 OPERATING AND MAINTENANCE MANUALS:

A. The Contractor shall furnish three Operating and Maintenance Manuals. The information in these manuals shall be bound in a hardback, loose-leaf binder or approved equivalent. The following shall be inscribed on the cover: The words "OPERATING AND MAINTENANCE MANUAL," the name and location of the building or project, and the name of the Contractor. The following shall be included in the Manual:

1. Identification: The Manual shall include the names, addresses and telephone numbers of each Sub-Contractor installing equipment and systems and of the local representative for each major item of equipment.

2. Index: The Manual shall have a Table of Contents and information shall be assembled with tab sheets to conform to the Table of Contents.

3.14 OPERATING AND MAINTENANCE INSTRUCTIONS SHALL BE AS FOLLOWS:

A. Manufacturer's Literature: Manufacturer's instructions for operation and maintenance of all mechanical equipment, including replacement parts list.

B. Written Instructions: Typewritten instructions for operation and maintenance of the system, composed of Operation Instructions, Maintenance Instructions and Maintenance Schedule.

C. Operation and Maintenance Instructions: A brief description of the system indicating proper setting of switches and other equipment shall be furnished for the purpose of providing control of the system and its components by the operator.

D. Maintenance Schedule: A list of each item of equipment requiring maintenance, showing the exact type of bearing on every component of each item of equipment, and the month of the year when each item of equipment should be inspected or serviced.

E. Verbal Instructions: Upon completion of the work, and at a time designated by the Owner, a competent Engineer from each supplier of major items or equipment shall be furnished to instruct the Owner's representative in the operation and maintenance of the equipment supplied by his company.

F. Mounting Frames: Wood frame and glass cover of adequate size to mount directories and typewritten instructions, securely mounted where indicated by Owner.

G. Binders: A complete set of the above data along with control diagrams as installed, typewritten sequence of operations, complete catalog data, calibrated information, spare parts lists, etc., for all control equipment shall be placed in a loose leaf binder with permanent cover, permanent identification section dividers and index. Provide three complete sets and deliver to the Owner.

1. Manufacturer's Literature: Include manufacturer's literature for all mechanical equipment. All equipment shall be identified by make, model and serial number. Electrical characteristics shall be noted. A complete parts list shall be included.

2. Operating Instructions: Provide a brief description of the system including proper setting of switches and other equipment. This may be provided as a part of the manufacturer's literature. If included in literature, provide an Index indicating on what page each item is located. Adjustments requiring the technical knowledge of the service agency personnel need not be included.

3. Maintenance Instructions: Provide a list of each item of mechanical equipment requiring inspection, lubrication or service with a description of the schedule and performance of such maintenance, including types of lubricant for each item of equipment. This may be provided as a part of the Manufacturer's Literature. If included in literature, provide an Index indicating on what page each item is located.

3.15 POSTED OPERATING INSTRUCTIONS:

A. Control diagram as installed. The diagram shall indicate all installed components. A typewritten sequence shall be included with or on the diagram, referring to component numbers or designations thereon. A copy of this diagram shall be posted in a mounting frame on or near the equipment of the system described and shall be plainly marked. In addition, a copy shall be included in the binder. Complete catalog data, calibration information, spare parts lists, etc. on all control equipment shall be included in the binder.

END OF SECTION

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SECTION 15852 - LOUVERS

PART 1 GENERAL

1.1 THE REQUIREMENT

A. The Contractor shall provide louvers, complete and operable, in accordance with the requirements of the Contract Documents.

B. The requirements of Section 09900 and Section 15500 are applicable to this Section.

C. The Contractor shall coordinate installation of louvers with the manufacturer of the respective metal building as specified in Section 13340.

1.2 REFERENCE SPECIFICATIONS, CODES, AND STANDARDS

AMCA 500 - L	Laboratory Methods of Testing Louvers for Rating
ASHRAE 70	Method of Testing the Performance of Air Outlets and Air Inlets

1.3 CONTRACTOR SUBMITTALS

A. Submit for approval, in accordance with Section 01340 Shop Drawings, Product Data and Samples.

B. In addition to the requirements of Section 01340, the Contractor shall submit the following:

1. Product Data: Sizes, finish, type of mounting, performance data. Submit schedule of louvers showing type, size location, application and noise level. Submit preparation instructions and recommendations, storage and handling requirements and recommendations, and installation methods.

2. Test Reports: Rating of inlet and out performance.

1.4 QUALIFICATIONS

1. The Manufacturer shall have a minimum of three years of experience specializing in products specified in this section.

1.5 WARRANTY

A. A written suppliers warranty shall be provided for the equipment specified in this section as required in Section 11.2, General Conditions.

PART 2 PRODUCTS

2.1 STATIONARY LOUVERS

A. Manufacturers or Approved Equal:

1. Ruskin

B. Type: 6 inch deep with drainable blades on 37.5 degree slope with a minimum free area of 55%.

C. Fabrication: Extruded aluminum frame and blades with factory baked enamel finish color to be selected.

D. Mounting: Metal panel wall installation.

E. Bird Screen: Bird screen with ½ inch square mesh for exhaust and ¾ inch for intake.

F. Insect Screen: Aluminum mesh, set in aluminum frame.

2.2 ADJUSTABLE ACOUSTICAL LOUVERS

A. Manufacturers or Approved Equal:

1. Ruskin

B. Type: 6 inch deep on 45 degree slope with a minimum free area of 30%.

C. Fabrication: Extruded aluminum frame and blades with factory baked enamel finish color to be selected.

D. Mounting: Metal panel wall installation.

E. Bird Screen: Bird screen with ½ inch square mesh for exhaust and ¾ inch for intake.

F. Insect Screen: Aluminum mesh, set in aluminum frame.

PART 3 EXECUTION

3.1 EXAMINATION

A. Coordinate opening locations and sizes for louvers with metal building manufacturer as specified in Section 13340. The Contractor shall confirm the supporting structure is designed to accommodate the louvers when subjected to design wind loads

3.2 INSTALLATION

A. The Contractor shall confirm location of louvers and make necessary adjustments in position to conform to architectural features, symmetry, lighting arrangement and mechanical equipment placement.

END OF SECTION

SECTION 15870 – FIBERGLASS REINFORCED PLASTIC (FRP) DUCTWORK

PART 1 GENERAL

1.1 THE REQUIREMENT

A. General: The CONTRACTOR shall furnish all labor, equipment, materials, tools, supplies, fittings, and appurtenances required for the design, fabrication, and installation of fiberglass reinforced plastic (FRP) ductwork including fittings, dampers, supports, and accessories as shown and as specified herein, in accordance with the requirements of the Contract Documents.

B. The items specified under this Section shall be furnished by manufacturers having experience in the manufacture of similar products and having a record of successful installations.

C. All FRP ductwork shall be manufactured of material suitable for the gases and chemicals specified, and shall be certified for such use on the shop drawings.

1.2 REFERENCE SPECIFICATIONS, CODES, AND STANDARDS

A. Commercial Standards:

1. ASTM C 581 Practice for Determining Chemical Resistance of Thermosetting Resins Used in Glass Fiber Reinforced Structures, Intended for Liquid Service.

2. ASTM D 638 Test Method for Tensile Properties of Plastics.

3. ASTM D 790 Test Methods for Flexural Properties of Unreinforced and Reinforced Plastics and Electrical Insulating Materials.

4. ASTM D 883 Definitions of Terms Relating to Plastics.

5. ASTM D 2563 Recommended Practice for Classifying Visual Defects in Glass-Reinforced Plastic Laminate Parts.

6. ASTM D 2583 Test Method for Indentation Hardness of Rigid Plastics by Means of a Barcol Impressor.

7. ASTM D 2584 Test Method for Ignition Loss of Cured Reinforced Resins.

8. NBS PS 15-69 Voluntary Product Standard, "Custom Contact-Molded Reinforced Polyester Chemical-Resistant Process Equipment."

9. When two or more of the above regulations are applicable, the more stringent requirement shall be met.

1.3 CONTRACTOR SUBMITTALS

A. General: CONTRACTOR shall submit administrative, shop drawings, samples, quality control, and contract closeout submittals of all equipment furnished this Section and in referenced Sections.

B. Shop Drawings and Samples: Shop drawings and samples shall be submitted in accordance with the requirements of Section 01340 Shop Drawings, Product Data and Samples.

1. Drawings showing details of construction of the ductwork including the following:

a. All minimum laminate thicknesses.
b. All laminate ply sequences.
c. Location and size of all stiffeners.
d. Construction details for all joints, stiffeners, penetrations, support attachments, flanges, turning vanes, or any other assembly.

2. Drawings showing all fittings, dampers, duct support locations, types, and details; wind and seismic brace locations, types, and details; and other appurtenances.

C. O & M Manuals: The CONTRACTOR shall provide operators and maintenance data for all equipment furnished for the project in accordance with Section 01730, Operation and Maintenance Data.

D. Tools: Special tools necessary for maintenance and repair of the equipment shall be furnished as a part of the WORK hereunder; such tools shall be suitably stored in metal tool boxes, and identified with the equipment number by means of stainless steel or solid plastic name tags attached to the box.

1.4 QUALITY ASSURANCE

A. CONTRACTOR shall submit the following:

1. MANUFACTURER's Certificate of Proper Installation

2. Functional Test Certification

3. Factory performance test reports

4. Special shipping, storage and protection, and handling instructions

5. MANUFACTURER's printed installation instructions

6. List of suggested spare parts to maintain the equipment in service for a period of 5 years. Include a list of special tools required for checking, testing, parts replacement, and maintenance.

7. List of special tools, materials, and supplies furnished with equipment for use prior to and during startup.

8. The FRP ductwork supplier shall provide certification for the following:

a. The resin used has been tested in accordance with ASTM C581 and that the resin is compatible with an environment consisting of air, hydrogen sulfide gas, methane, various aromatic hydrocarbon vapors, droplets of salt water, and droplets of water containing sodium hypochlorite, sodium hydroxide, and sulfuric acid.
b. The fiberglass used has a flame spread rating of 25 or less and as measured in accordance with NFPA No. 255, Standard Method of Test for Surface Burning Characteristics of Building Materials.
c. Samples: Samples of the manufacturer's standard gel coat colors shall be submitted to the ENGINEER for color selection.

B. Warranty

1. A written suppliers warranty shall be provided for the equipment specified in this section as required in accordance with the General Conditions.

PART 2 PRODUCTS

2.1 DUCTWORK DESIGN

A. General: All FRP exposed, concrete encased and buried air ducts, plenums and exhaust stacks shall be designed as specified herein.

B. Wall Thickness: Minimum wall thickness shall be 1/4-inch. Additional thickness may be required to meet deflection, specific loading requirements or duct pressure operating requirements.

C. Dimensions: The duct and plenum dimensions indicated on the drawings are net inside, indicating the clear space required inside the duct or plenum after lining is installed. Actual duct dimensions shall be increased to accommodate lining material, where lining is required.

1. Design calculations for these conditions shall be furnished with the shop drawings.

D. Deflection for exposed installation: The ductwork shall be designed to meet the following specification with respect to supports. Supports shall be designed and installed furnished by the Contractor at no extra cost. Maximum deflection of a side on a rectangular duct shall not exceed 2 percent of the width of the side at a test vacuum pressure of 6 inch W.C. Maximum deflection of round duct shall not exceed 2 percent of the duct diameter under an imposed hoop (point) loading of 550 lbs. After installation, horizontal rectangular ducting shall not sag in excess of 2 percent of the shortest side as measured from a straight and true centerline of the duct to the actual midpoint of the installed duct. Similarly, maximum sag of horizontally installed round duct shall not exceed 2 percent of the diameter. Duct supports shall be designed and installed such that the maximum deflections and sags specified are not exceeded. Any internal support components of the duct work shall not increase the system pressure drop.

E. Duct Supports:

1. Duct supports and anchorage shall be designed for static, dynamic, wind, and seismic loads as presented on Sheet No. GS-1 of the Contract Drawings.

2. Calculations for supports shall be signed by an engineer registered in the State of California.

3. CONTRACTOR shall note that the pipe support details in the DRAWINGS are not designed to resist seismic forces. CONTRACTOR shall design and install additional supports as needed to resist the seismic condition listed above. Design calculations shall be submitted to the ENGINEER in accordance with Section 01340, Shop Drawings, Product Data and Samples.

F. Expansion and Contraction: Expansion joints shall be provided as needed. The minimum expansion and contraction provided for in the expansion joint specified elsewhere in this section shall be increased as needed due to calculated thermal movement. Expansion and contraction shall be determined on the basis of a temperature differential of 90°F. Thermal coefficients shall be determined by test for the laminate used, and the maximum expansion and contraction for the expansion joints.

2.2 MATERIALS OF CONSTRUCTION

A. Resin: The duct shall be constructed using a high quality corrosion-resistant resin such as Hetron 992, Dow Derakane 411, or ICI America's Atlac 580. Selection of the proper resin for the chemical environment shall be based on the corrosion guides and previous experience of the resin manufacturer. The resin shall not contain any fillers except as required for viscosity control.

B. Reinforcing Material: The reinforcing material shall be a commercial grade of glass fiber having a suitable bond between glass reinforcement and resin, such as manufactured by Owens-Corning, or Johns-Manville.

2.3 CONSTRUCTION

A. General: Ducts shall be manufactured to the sizes and tolerances of National Bureau of Standards Voluntary Product Standard PS 15-69 except as modified in these specifications.

1. Physical Properties of Laminate: The laminate shall, in all cases, have the following physical properties:

		ASTM Test	Units	Value
2.	Physical Properties (at 73°F)			
3.	Minimum Ultim. Tensile Strength	D638	psi	12,500
4.	Minimum Flexural Strength	D790	psi	19,000
5.	Minimum Flexural Modulus of Elasticity (tangent)	D790	psi	800,000

B. Laminate Construction: The laminate shall consist of a corrosion liner, a structural laminate, and an exterior layer.

1. Corrosion Liner: The inner surface of all laminates shall be a resin-rich C-glass veil and E-glass mat with a total thickness of 0.050 inch. The corrosion liner shall be applied in not less than two layers.

2. Structural Laminate: The corrosion liner shall be followed by a structural laminate of either hand-layup or filament wound construction. Minimum allowable structural

laminate thickness shall be the minimum wall thickness specified in this section, less the corrosion liner thickness.

3. Exterior Layer: The exterior layer shall be resin-rich and reinforced with one layer of C-glass surfacing veil. The exterior layer shall be finished with a gel coat consisting of polyester resin, a pigment for color, and an ultra-violet light inhibitor. Minimum thickness of the exterior layer shall be 0.020 inch. The pigment and ultraviolet light inhibitor can be excluded in the encased and buried ducts.

C. Flanges: Flanges shall conform to the specifications in PS 15-69.

1. Turning Vanes: Smooth bends or internal turning vanes shall be provided at elbows, tees, and other points in the duct system where air flow changes direction. Square-turn elbows shall be fitted with shop-fabricated double-blade turning vanes mounted inside rails. Construction shall be of the same material as the ductwork and rigid enough to prevent vibration at high air flow.

2. Drainage: Ducting shall be specifically designed to facilitate water drainage; raised lips at duct joints will not be accepted.

2.4 WORKMANSHIP

A. Visual Defects: ASTM D2563 shall be used for quality control of both filament-w o u n d and hand lay-up construction. Acceptance levels shall be as follows:

Process Surface:	Defects:
Blisters	None
Burned Areas	None
Chips	None
Cracks	None
Crazing	None
Dry Spots	None
Entrapped Air	None at surface. If in laminate 1/16-in dia max and 5/sq max
Exposed Glass	None
Exposed Cut Edges	None
Foreign Matter	None
Pits	Max 1/8-in dia X 1/32-in deep, max 10/sq ft.
Scratches	None (coated)
Surface Porosity	None

Wrinkles	Max deviation 10 percent of wall thickness.
Sharp Discontinuity	None
Non-Process Surface:	Defects:
Blisters	Max 1/4-in X dia 1/16-in high.
Burned Areas	None
Chips	Max 1/4-in with max thickness of 20 percent of wall.
Cracks	None
Crazing	Slight
Dry Spots	Max 2 sq in/sq ft
Entrapped Air area.	1/8-in dia max; no more than 3 percent of
Exposed Glass	None
Exposed Cut Edges	None
Foreign Matter	None if it affects the properties of laminate.
Pits	Max 1/8-in dia X 1/16-in deep.
Scratches	None (coated)
Surface Porosity	None
Wrinkles	Max deviation 20 percent of wall thickness, but not exceed 1/8-in.
Sharp Discontinuity	None

B. If the area fails to meet the requirements of entrapped air or voids in less than 40 percent of the total surface, those areas may be repaired and reinspected. If the defective areas exceed 40 percent of the total surface, the entire vessel shall be rejected.

C. Shop Inspection: The ENGINEER shall be permitted access to the plant area at all times during fabrication and shall be notified one week prior to the estimated date of tests and/or inspections. Final inspection and approval shall be obtained prior to shipment unless written waiver is obtained. The shop inspection of the equipment shall include the following:

1. Check for compliance with drawing dimensions and adherence to construction standards.

2. An acetone wipe test to check surface cure. No surface tackiness is permitted.

3. A Barcol hardness test; at least 90 percent of manufacturer's specified hardness must be attained.

4. Examination of laminated (nozzle) cutouts.

5. A hydrotest of at least 24 hours duration to check for leaks.

2.5 DAMPERS

A. Control dampers shall be the locking quadrant type and shall be constructed of a vinyl ester resin fiberglass. The thickness of the flange mount channel frame and blade shall be recommended by the manufacturer. Damper components shall be epoxied together and/or held in place with monel fasteners. Blade shall be stiffened as required. Frame shall be equipped with full circumference blade stop. Blade shall have a full circumference viton seal.

B. A mechanism for positively locking the damper in position shall be provided. Each control damper shall be furnished with a hand lever or chain operator whenever it is more than six feet above the surrounding ground elevation.

C. Chains shall be aluminum not less than 1/4-inch nominal size, and shall be looped to extend within 4 feet above the operating level. Twist chains or wire chains will not be accepted. Chain sprocket wheels shall be of the same material as the chain.

D. Levers, chains, and chain sprocket wheels may be constructed of aluminum. It is the manufacturer's responsibility to furnish all associated parts of the damper of sufficient strength to support the chain.

E. Dampers with chain operators shall be furnished with an indicator to show the open and closed position. The indicator shall be clearly visible from the operating level.

F. All control dampers shall be able to operate in a partially closed position at a differential pressure of 4-inch w.c.

G. All control dampers shall be furnished with seals to reduce leakage. Permissible leakages shall not be in excess of those in the published literature of the named manufacturers.

H. Manufacturer: All dampers shall be as manufactured by Swartwout, Viron International or equal.

2.6 DUCT SUPPORTS

A. Duct supports shall be designed to allow a maximum deflection of ½ “ deflection at midspan. Maximum spacing between supports shall not exceed 20 feet. Duct supports shall be provided at all changes of direction.

B. Point loads from supports are not acceptable. Protective sleeves that have 120° of contact and a minimum of 16” long or a minimum support width of 2” for 12” and 1 ¾” for 8” shall be utilized.

C. All supports will be properly anchored to positively restrain the movement of the duct.

D. All support materials utilized shall be FRP, PVC, or galvanized.

2.7 BIRDSCREENS AND INLET GRILLES

A. All air intakes, except in the belt filter press hoods, shall be provided with FRP inlet grilles and bird screen of No. 8 mesh not less than 12 gage 316 stainless steel wire. Each bird screen shall be provided with a Type 316 stainless steel frame. Screens and grilles shall be securely held in place but shall be conveniently removable.

2.8 METAL ACCESSORIES

A. All metal encased in or attached to any fiberglass item shall be Type 316 SS.

2.9 PROTECTIVE COATING

A. Fiberglass ductwork shall not be painted. The color shall be impregnated in the exterior layer. Color shall be selected by the City.

2.10 MANUFACTURERS

A. MANUFACTURER's Experience: The materials and equipment covered by this specification are intended to be standard materials and equipment of demonstrated successful performance and supplied by a manufacturer who has been actively engaged in the supply of similarly sized FRP ducting for a minimum of 10 years. Equipment shall be designed and constructed in accordance with the highest standards of the industry and shall be installed in accordance with the MANUFACTURER's recommendations and the Contract Documents.

B. Manufacturers or Equal:

1. Harrington Industrial Plastics, Inc.

2. Ceilcote Company

3. Beverly Pacific

PART 3 EXECUTION

3.1 DELIVERY AND STORAGE

A. A complete set of MANUFACTURER's instructions covering storage, installation, operation, lubrication, and maintenance shall be furnished to the OWNER no later than the date the equipment is shipped. Care during storage and procedures for installation, lubrication, and startup of the equipment and motors shall be in strict conformance with the MANUFACTURER's instructions.

3.2 GENERAL

A. Installation shall be in strict accordance with the manufacturer's instructions and recommendations.

B. No ductwork shall be fabricated or installed until it has been carefully coordinated with equipment specified elsewhere. Duct dimensions shown are "net" inside clear.

3.3 INSTALLATION

A. Duct hangers and supports shall be fabricated out of materials as shown on the Drawings. Attachment of hangers of supports to fiberglass ducting with screws is unacceptable.

B. All nuts, bolts and washers shall be type 316 stainless steel. Washers shall be used under all nuts and bolt heads.

C. Gaskets shall be 1/4-inch thick full-face made of closed cell neoprene, sponge, silicone coated. Gaskets shall have a shore A hardness of not less than 50.

D. Field joints shall be 100 percent sanded just prior to wet lay up (inside and outside). Field joints shall be made by wrapping with strips of reinforcement saturated with resins. The width of the first layer shall be 2 inches minimum and each layer shall increase in width uniformly until at least the thickness of the heaviest section being joined is achieved. Total minimum width of joint shall be 9 inches. Mating edges shall be coated with resin to cover all cut edges, and all voids shall be filled with a resin putty mix. The inside surface of joints shall be sealed with a wax resin mix where joints are not accessible. Where internal joints are accessible they shall be laid up with two 1-1/2 ounce mats then covered with a C-glass veil and sealed with a wax resin mix. All field joints shall meet or exceed duct section properties. Color match adjacent ducts shall be as close as possible.

3.4 EXPANSION JOINTS:

A. Expansion joints shall be one piece bellows type made of 1/4-inch thick material with two-ply polypropylene reinforcement with a Hypalon exterior layer and butyl interior layer. The expansion joint shall be designed to span a 1 1/2-inch gap and to allow for widening of that gap to 3 inches, unless noted otherwise on the drawings or as needed by calculation.

B. Flexible connectors shall be made with flanged materials with two-ply polypropylene reinforcement with a Hypalon exterior layer and butyl interior layer, or approved equal. A minimum clearance of 3 inches shall be maintained between the ends of duct or between the fan and end of duct. Flexible connectors shall be furnished at each side of all centrifugal fan connections to a duct.

C. Expansion joints and flexible connectors between flangeless ducts and fan inlets shall be attached with two stainless steel bands.

D. A watertight and airtight seal shall be provided at all joints.

END OF SECTION

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PART G – Technical Specifications

City of Brentwood
Brentwood, California

FOR THE CONSTRUCTION OF THE

WASTEWATER TREATMENT PLANT EXPANSION – PHASE II

PROJECT NO. 592-59140

Volume 3 of 3
Technical Specifications Division 16

January 2020

In Association with

TJC and Associates, Inc.

Burks Toma Architects

Black and Veatch

RHAA Landscape Architects

SEMCO Consultants, Inc.

JDH Corrosion Consultants

Cal Engineering and Geology, Inc.

HYT Corporation

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RESPONSIBLE ENGINEER SEALS AND SIGNATURES

DIVISION 01 – GENERAL REQUIREMENTS

REGISTERED PROFESSIONAL ENGINEER
ANTHONY T. VALDIVIA
No. 66847
Exp. 09-30-20
CIVIL
STATE OF CALIFORNIA

REGISTERED PROFESSIONAL ENGINEER
RICHARD KERR THOW
No. S 5620
EXP. 09/30/21
STRUCTURAL
STATE OF CALIFORNIA

DIVISION 02 – SITEWORK

REGISTERED PROFESSIONAL ENGINEER
ANTHONY T. VALDIVIA
No. 66847
Exp. 09-30-20
CIVIL
STATE OF CALIFORNIA

REGISTERED PROFESSIONAL ENGINEER
DANIEL J. PELUSO
GE 2367
GEOTECHNICAL
STATE OF CALIFORNIA

LICENSED LANDSCAPE ARCHITECT
Barbara D. Lundburg License No. 1691
Signature
3-31-20
Renewal Date
3-5-19
Date
STATE OF CALIFORNIA

DIVISION 03 – CONCRETE

REGISTERED PROFESSIONAL ENGINEER
RICHARD KERR THOW
No. S 5620
EXP. 09/30/21
STRUCTURAL
STATE OF CALIFORNIA

DIVISION 04 – MASONRY – Not Used

DIVISION 05 – METALS

REGISTERED PROFESSIONAL ENGINEER
RICHARD KERR THOW
No. S 5620
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STRUCTURAL
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DIVISION 06 – WOOD AND PLASTICS

LICENSED ARCHITECT
KAREN BURKS
NO. C-12893
EXP. 10/31/21
ARCHITECT
STATE OF CALIFORNIA

DIVISION 07 – THERMAL AND MOISTURE PROTECTION

LICENSED ARCHITECT
KAREN BURKS
NO. C-12893
EXP. 10/31/21
ARCHITECT
STATE OF CALIFORNIA

DIVISION 08 – DOORS AND WINDOWS

LICENSED ARCHITECT
KAREN BURKS
NO. C-12893
EXP. 10/31/21
ARCHITECT
STATE OF CALIFORNIA

DIVISION 09 – FINISHES

LICENSED ARCHITECT
KAREN BURKS
NO. C-12893
EXP. 10/31/21
ARCHITECT
STATE OF CALIFORNIA

REGISTERED PROFESSIONAL ENGINEER
ANTHONY T. VALDIVIA
No. 66847
Exp. 09-30-20
CIVIL
STATE OF CALIFORNIA

DIVISION 10 – SPECIALTIES

REGISTERED PROFESSIONAL ENGINEER
ANTHONY T. VALDIVIA
No. 66847
Exp. 09-30-20
CIVIL
STATE OF CALIFORNIA

DIVISION 11 – EQUIPMENT

REGISTERED PROFESSIONAL ENGINEER
ANTHONY T. VALDIVIA
No. 66847
Exp. 09-30-20
CIVIL
STATE OF CALIFORNIA

REGISTERED PROFESSIONAL ENGINEER
JESSE W. WALLIN
C77408
CIVIL
STATE OF CALIFORNIA
08/14/19

DIVISION 12 – FURNISHINGS – Not Used

DIVISION 13 – SPECIAL CONSTRUCTION

REGISTERED PROFESSIONAL ENGINEER
ANTHONY T. VALDIVIA
No. 66847
Exp. 09-30-20
CIVIL
STATE OF CALIFORNIA

REGISTERED PROFESSIONAL ENGINEER
RICHARD KEER THOW
No. S 5626
EXP. 09/30/21
STRUCTURAL
STATE OF CALIFORNIA

REGISTERED PROFESSIONAL ENGINEER
PAUL J. GIORSETTO
No. E 11674
Exp. 09/30/20
ELECTRICAL
STATE OF CALIFORNIA

REGISTERED PROFESSIONAL ENGINEER
MOHAMMED ALI
No. CR 1035
Exp. June 30, 2019
CORROSION
STATE OF CALIFORNIA

DIVISION 14 – CONVEYING SYSTEMS

REGISTERED PROFESSIONAL ENGINEER
ANTHONY T. VALDIVIA
No. 66847
Exp. 09-30-20
CIVIL
STATE OF CALIFORNIA

DIVISION 15 – MECHANICAL

REGISTERED PROFESSIONAL ENGINEER
ANTHONY T. VALDIVIA
No. 66847
Exp. 09-30-20
CIVIL
STATE OF CALIFORNIA

REGISTERED PROFESSIONAL ENGINEER
BRET B. TRESIDDER
No. 1165
Exp. 09/30/20
FIRE PROTECTION
STATE OF CALIFORNIA

DIVISION 16 – ELECTRICAL

REGISTERED PROFESSIONAL ENGINEER
PAUL J. GIORSETTO
No. E 11674
Exp. 09/30/20
ELECTRICAL
STATE OF CALIFORNIA

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CITY OF BRENTWOOD
Brentwood, California

WASTEWATER TREATMENT PLANT EXPANSION - PHASE II

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SECTION 16000 - COMMON WORK RESULTS FOR ELECTRICAL

PART 1 GENERAL

1.1 DESCRIPTION

A. Division 16, Electrical covers the work necessary for the complete electrical systems for the City of Brentwood Wastewater Treatment Plant Expansion Project. Furnish all materials, labor, and equipment as specified herein, in other Division 16 Specification Sections as listed below, and the Drawings for a complete, operational, tested, and commissioned electrical system.

B. The requirements of Division 16, Electrical in their entirety apply to all electrical work and equipment furnished on this Project whether furnished or specified under this or other Divisions of these Specifications.

C. The work shall include furnishing, installing, and testing the equipment and materials detailed in the following Sections. Where differences exist between the technical equipment Specification Sections of Division 16 and this Section, the specific equipment Specifications shall govern.

1. 16002 – Electrical and Instrumentation Demolition and Modifications
2. 16060 – Grounding and Bonding for Electrical Systems
3. 16075 – Electrical Identification
4. 16080 – Electrical System Analyses and Commission Field Testing
5. 16120 – Low Voltage Conductors and Cables
6. 16121 – Medium Voltage Cables
7. 16122 – Fiber Optic Cables and Equipment
8. 16130 – Raceways and Boxes
9. 16140 – Wiring Devices
10. 16145 – Miscellaneous Electrical Equipment
11. 16220 – Low Voltage Motors
12. 16230 – Standby Diesel Engine-Generator Systems
13. 16240 – Station Battery System
14. 16260 – Low Voltage Adjustable Speed Drives
15. 16263 – Static Uninterruptible Power Supplies (UPS)
16. 16265 – Reduced Voltage Solid State Motor Controllers
17. 16271 – Pad Mount Liquid Filled Transformers

18. 16290 – Electrical Power Monitoring System

19. 16350 – Medium Voltage Switchgear

20. 16360 – Unit Substations

21. 16436 – 480 Volt Switchgear

22. 16440 – Switchboards

23. 16441 – Panelboards

24. 16442 – Motor Control Centers

25. 16460 – Low Voltage Distribution Transformers

26. 16500 – Lighting Systems

27. 16600 – Underground Ducts and Raceways for Electrical Systems

28. 16910 – Fire Detection and Alarm Systems

D. The work shall include the following:

1. Furnishing and installing complete operational systems functionally in accordance with the intent of the Contract Documents as specified and as shown on the Drawings.

2. Coordinating the details of equipment layouts and construction for all Specification Divisions which affect the work covered under Division 16, ELECTRICAL.

3. Furnishing and installing all incidental items not specifically shown or specified, but which are required by good practice, workmanlike standards, and technical standards of the industry to provide complete functional systems.

4. Coordination and work associated with equipment provided under technical Divisions 2 through 15 of these Specifications including but not limited to: mechanical systems packaged with electrical equipment, motor operated valves with integral controls, pump motors with motor protection controls, motors with integral variable frequency drives, field instrumentation.

5. Coordination and work associated with Sections specified in accordance with Section 13400 covering Process Control and Instrumentation Systems, for installation of plant control system including but not limited to: control networks and media converters, computers, control panels, conduit, wire, fiber optic cables, and terminations as required.

6. Electrical service modifications from the Power Company.

7. Conduit, wire and field connections for all motors, motor controllers, control devices, control panels and electrical equipment furnished under other technical sections of these Specifications.

8. Conduit, wiring and terminations for all field-mounted instruments furnished and mounted under other Divisions, including process instrumentation primary elements, transmitters, local indicators, and control panels; lightning and surge protection equipment wiring at process instrumentation transmitters and analyzers; instrumentation disconnect switches; installation of vendor furnished cables specified under other Divisions.

9. A complete raceway system for the data highway cables, fiber optic, and specialty cable systems. Install the data highway cables, fiber optic, and other specialty cable systems furnished under Division 13 in accordance with the system manufacturers' installation instructions. Review the raceway layout, prior to installation, with the control or computer system supplier(s) and the cable manufacturer(s) to ensure raceway compatibility with the systems and materials being furnished. Where redundant cables are furnished, install cables in separate raceways.

10. Installation of variable frequency drives, and other motor control equipment, accessories, and appurtenances furnished under other Divisions.

11. Power wiring for all heating, ventilating, and air conditioning equipment furnished under other related Divisions, including disconnect switches, raceways, wiring, terminations. Refer to HVAC Drawings for the equipment requirements and locations of 120 Volt thermostats. Provide a 3/4-in C, 2 No. 12 AWG and 1 No. 12 AWG ground between each device and its respective control thermostat.

12. Certain pieces of laboratory, shop, or process equipment (e.g., still, water-baths, fume hood, etc.) are furnished unassembled. Perform all electrical work necessary to make such equipment operative.

13. Modifications to existing control systems including installation of auxiliary motor starter contacts, relays, switches, as required to provide the control functions or inputs as shown on the Drawings.

14. Verify all existing wiring and connections noted for revisions for correctness. Trace the circuits in the field and develop the wiring diagrams necessary for completion of the work. Document all changes made to the wiring diagrams and return a marked-up set of Record Drawings to the City after the work is complete.

15. Coordinate the sequence of demolition with the sequence of construction to maintain plant operation in accordance with Section 01010. Remove and demolish equipment and materials in such a sequence that the existing and proposed plant will function properly with no disruption of treatment processes and as specified under Section 16002.

16. Modifications to existing motor control centers, switchboards, panelboards, and motor controllers including installation of circuit breakers or disconnection of circuits as required to provide power supplies to new and existing equipment to maintain the plant in operation and as specified in Section 16002.

17. Seismic design calculations, anchoring, and restraints for electrical equipment and systems requiring such restraints as required under Section 01612.

18. Wind design calculations, anchoring, and restraints for electrical equipment and systems requiring such restraints as required under Section 01612.

19. Short Circuit Study, System Protective Device Coordination Analysis, Arc Flash Calculations, and other electrical system analysis work.

20. Furnishing and installing standby Engine-Generator including all installation permitting, startup, and operational permitting.

21. Testing of the electrical equipment and making final settings for the electrical protective devices.

E. Each bidder shall, before preparing their proposal, visit all areas of the existing buildings and structures in which work is to be performed and inspect carefully the present installation. The submission of a proposal by a bidder shall be considered evidence that the bidder has visited the facility, buildings, and structures; noted the locations and conditions under which the work will be performed; and incorporated these locations and conditions into their proposal with respect to the factors governing the work.

F. Sequencing and Scheduling

1. Coordinate electrical equipment installation with other building components.

2. Arrange for chases, slots, and openings in the building structures during the progress of construction to allow for the electrical installation.

3. Coordinate installing required supporting devices and set sleeves in poured-in-place concrete and other structural components as they are constructed.

4. Sequence, coordinate, and integrate the installation of electrical materials and equipment for efficient flow of the work. Coordinate the installation of large equipment requiring positioning prior to closing in the building.

5. Verify final locations for rough-ins with field measurements and with the requirements of the actual equipment to be connected.

1.2 RELATED WORK

A. Section 01612 – Seismic Design Criteria

B. Section 01614 – Wind Design Criteria

C. All trenching, drilling, backfill, compaction, and surface restoration shall be as indicated on the Drawings and as required under Division 2 of these Specifications.

D. All concrete and reinforcement shall be as indicated on the Drawings and as required in Division 3 of these Specifications. However, the responsibility of furnishing and installing the underground systems shall be included under this Section.

E. Section 11502 – Geared Single Stage Centrifugal Blower Packages

F. Section 11600 – Biosolids Dryer System

G. Mixer motors and drives are specified in Sections 11205 and 11206.

H. Instrumentation and Controls are included under Section 13400 and related Sections.

I. Section 13550 – Aeration Control System

J. Electrical requirements as specified under Section 15050, Basic Mechanical Materials and Methods

K. HVAC, plumbing, and associated building controls as specified under Division 15.

L. Other building support equipment requiring electrical work are specified in the other Technical Sections of these Specifications: Divisions 2 through 15.

1.3 SUBMITTALS

A. General

1. Submit manufacturers' descriptive information and shop drawings for all equipment, material, and devices furnished under Division 16 Sections. Prepare and format submittals in accordance with Section 01340 and as specified.

2. Mark submittals to clearly identify proposed equipment including accessories, options, and features and to exclude information, products, options, or parts not applicable to the Project.

3. If the equipment installed during construction does not match the equipment that was approved by the Engineer during submittal review, the Contractor shall resubmit all documentation related to the installed equipment as specified. Should the unapproved equipment be found not to be in conformance with the Contract Documents, it shall be removed and replaced with suitable equipment at the Contractor’s expense.

4. Review of submittal information by the Engineer shall not relieve the Contractor from responsibility for deviations from Drawings and Specifications, unless he has in writing at time of submission requested and received written approval from the City for specific deviations. Review of submittal information shall not relieve the Contractor from responsibility for errors and omissions in shop drawings or literature.

5. Where submittal documents are submitted in electronic format, the engineer reserves the right to request a hard copy of the package for review of complex drawings or shop drawing information.

6. For large electronic packages over 50 pages in length, provide suitable electronic indexing or book marking to match the table of contents, tabulations, drawings, individual product material catalog cut sheets or other documents types provided. Indexing or bookmarking shall be used to facilitate navigation and review of the document. Large electronic packages submitted without such indexing shall be returned to the Contractor unreviewed.

7. Check information and shop drawings for accuracy prior to submittal. Stamp shop drawings with the date checked and a statement signed by the Contractor indicating that the information and shop drawings conform to the requirements of the Contract Documents. This statement shall also list all exceptions incorporated into the Contract Documents. Shop drawings without this signed and dated statement shall be returned unreviewed, marked NOT APPROVED.

8. The Engineer's review of the submittal information shall only be for general conformance with the design concept and the information given in the Contract Documents. The Engineer’s review does not relieve the Contractor from responsibility for errors or omissions in their submittal; Contractor’s compliance with the Plans and Specifications, applicable laws, codes and regulations; or the Contractor's responsibility of addressing any deviations from the Contract Documents.

9. Review of a specific item in a submittal shall not constitute review of an assembly of which the item is a component.

10. The Contractor is responsible for: confirming and correlating all quantities, dimensions, details, tolerances, and clearances; for all information that pertains to the fabrication processes or to the means, methods, techniques, sequences and procedures of construction; coordination of the Work with that of all other trades and for performing the Work in a safe and satisfactory manner. All dimensions shall be field verified at the job site and coordinated with the work of all other trades performing work under this Contract.

B. Conduit Routing and Layout Drawings:

1. Submit raceway routing and mounting layout drawings for review and approval.

2. Installation of any raceways in areas where interconnection diagrams are included on the Drawings shall not proceed until layout drawings have been submitted and approved.

3. The Contractor shall use the interconnection diagram schematic representation of the raceway system with information provided on the Drawings and the conduit schedules to prepare the layout drawings.

4. Prepare layout drawings in AutoCAD 2014 format or later using the Contract Document plan drawings as backgrounds. Drawings shall be submitted in PDF format suitable for direct printing in 11x17 format.

5. Layout drawings shall detail specific raceway routing using the individual conduit numbers from the Interconnection Diagram or Conduit Schedule. Every indicated conduit shall be included on the layout drawings including lighting fixture and wiring devices.

6. Indicate mounting method to be used for each routing area and indicate installation concealed or exposed as required.

7. Update the layout drawings with any modifications made during field installations and include the updated layout drawings with the final Record Drawing set specified below.

C. Seismic requirements:

1. Submit seismic mounting and anchorage calculations for electrical equipment as follows:

a. Where specifically called for in the specific Technical Sections of Division 16.

b. Where required under the requirements of Section 01612.

2. Submit an itemized list 90 days following Notice To Proceed indicating all systems and equipment for which seismic anchoring will be provided under Contract. List shall include equipment designation, raceway identifier, cable tray tag, etc. as shown on the Contract Documents. List shall also include the Electrical Drawing number where the specific anchoring system is to be located.

3. Prepare and submit seismic anchorage and mounting calculations as specified conforming to the requirements and technical criteria per Section 01612.

4. Installation of equipment shall not proceed until mounting and anchoring calculations have been submitted and approved.

D. Operation and Maintenance Data

1. Submit operations and maintenance data for equipment furnished under this Division, in accordance with Section 01730. The manuals shall be prepared specifically for this Project. Include catalog data sheets, layout drawings, control drawings, equipment lists, functional descriptions, and bills of materials or parts lists with replacement part numbers.

2. Manual provided under this Section shall consist of the individual O&M information provided under the other technical sections of Division 16. Coordinate and organize this information into a single, comprehensive, electrical system O&M manual subject to the specified requirements.

3. Manuals shall include the following as a minimum:

a. A comprehensive index of the major equipment provided.

b. A functional description of the entire system with references to the individual system elements, schematic drawings, and instructions.

c. A complete "As-Built" set of approved shop drawings.

d. A complete list of the equipment supplied, including serial numbers, ranges, and pertinent data.

e. A table listing sorted by equipment designation of the "as left" settings for all control, timing, and protective relays defining all timing, alarm, and trip setpoints.

f. System schematic drawings "As-Built," illustrating all components electric connections of the systems supplied under this Section.

g. Detailed service, maintenance and operation instructions for each item supplied.

h. Special maintenance requirements particular to this system shall be clearly defined, along with special calibration and test procedures.

i. Complete parts list with stock numbers, including spare parts.

4. Incorporate final versions of electrical analyses reports and studies as specified under Section 16080. Submit final system model databases in executable native format of the software used for the analyses.

5. Incorporate final versions of electrical test reports including final device settings as specified under Section 16080.

1.4 STANDARDS, CODES, PERMITS, AND REGULATIONS

A. Electrical equipment, materials and installation shall comply with the National Electrical Code (NEC, NFPA 70) 2014 Edition, including the California Electrical Code (CEC-2016) Amendments. All references to the NEC included in the Contract Documents shall be interpreted to be referenced to this version with the California Amendments as specified.

B. Perform work; furnish, install, and test materials and equipment in full accordance with applicable rules, regulations, requirements, and specifications of the following. Where reference is made to one of the standards, the revision in effect at the time of bid opening shall apply.

1. Local Laws and Ordinances

2. State and Federal Laws

3. State Building Codes

4. State Fire Marshal

5. California Code of Regulations

a. Title 24, Part 3 – California Electrical Code (NEC with California Amendments)

6. California Division of Occupational Safety and Health (DOSH), Cal OSHA

7. Institute of Electrical and Electronic Engineers (IEEE)

a. Standard C2: National Electrical Safety Code (NESC)

8. National Electrical Contractors Association (NECA)

a. National Electrical Installation Standards (NEIS)

9. National Electrical Manufacturer's Association (NEMA)

a. NEMA Publication 250: Enclosures for Electrical Equipment (1000 Volts Maximum)

10. National Fire Protection Association:

a. NFPA 820: Fire Protection in Wastewater Treatment and Collection Systems

11. InterNational Electrical Testing Association, Inc (NETA)

    a. Acceptance Testing Specifications for Electrical Power Distribution Equipment and Systems

    b. Standard for Maintenance Testing Specifications for Electrical Power Distribution Equipment and Systems

12. Pacific Gas and Electric Company (PG&E)

    a. Electric & Gas Service Requirements (Green Book)

    b. Section 11, Electric Switchboard: 601 Through 25,000 Volts and Primary Services

    c. Utility Bulletin: TD-2999-030, Technical Requirements for Electric Service Interconnection at Primary Distribution Voltages

C. Where conflicts may occur between the above items the more stringent applicable requirements shall apply. Wherever the requirements of the Specifications or Drawings exceed those of the above items, the requirements of the Specifications or Drawings govern. Code compliance is mandatory. Construe nothing in the Contract Documents as permitting work not in compliance with applicable codes and standards.

D. Underwriters Laboratories (UL) listing is required for all equipment and materials where such listing is offered by the Underwriters Laboratories. Safety labeling and listing by other organizations, such as ETL Testing Laboratories, Factory Mutual (FM) or other nationally recognized entity may be substituted for UL labeling and listing if approved by the Engineer. Provide UL service entrance labels for all equipment required by the NEC to have such labels.

E. Equipment, materials, and installation shall comply with the requirements of the local authority having jurisdiction. Obtain all permits and pay all fees required by any governmental agency or utility having jurisdiction over the work. Coordinate and arrange all inspections required by these agencies. On completion of the work, submit satisfactory evidence to the Engineer that the work is acceptable to the regulatory authorities having jurisdiction.

1.5 INTERPRETATION OF CONTRACT DOCUMENTS

A. The Contract Drawings indicate the extent, general location, and arrangement of equipment. Duct bank and conduit runs are diagrammatic and may not show the exact locations for installation. Verify locations of conduit stub-ups based upon conduit entry space of equipment furnished from the manufacturer’s certified shop drawings, by inspection of the actual equipment to be installed, and coordinated with other trades. Stub-up conduits as near as possible to equipment terminal enclosures.

B. Except where dimensions are shown, the locations of equipment, fixtures, outlets, and similar devices shown on the Drawings are approximate only. Exact locations shall be determined by the Contractor and approved by the Engineer. Obtain information relevant to the placing of electrical work including final equipment dimensions and installation criteria. In case of any interference with other work, proceed as directed by the Engineer and furnish all labor and materials necessary to complete the work in an approved manner.

C. Unless otherwise approved by the Engineer, conduits shown exposed on the Drawings shall be installed surface mounted or suspended as applicable; conduit shown concealed on the Drawings shall be installed in walls, floor slabs, or ceilings as applicable.

D. Install each 3 phase circuit in a separate conduit unless otherwise shown on the Drawings.

E. Conduit routing, layouts, or “home runs” shown on the Drawings are not intended to show the number of fittings or other installation details. Furnish all labor and materials necessary to install and place in satisfactory operation all power, lighting and other electrical systems shown.

F. Interconnection diagrams where provided on the Drawings are intended to show schematic connections between components. Final routing and installation of associated raceways shall use information on the Drawings as a guide for routing as detailed in the Contractor conduit layout submittals.

G. Verify the exact locations and mounting heights of lighting fixtures, switches, and receptacles prior to installation.

H. Number and size of wires which shall be installed in runs of conduit where not shown on the Drawings shall be determined from the one line, schematics, connection, interconnection, and control diagrams of the actual equipment furnished.

I. Raceways and conductors for lighting, switches, receptacles and other miscellaneous low voltage power and signal systems specified are not shown on the Drawings. Raceways and conductors shall be provided as required for a complete and operating system. Homeruns, as shown on the Drawings, are to assist the Contractor in identifying raceways to be run exposed and raceways to be run concealed. Raceways shall be installed concealed in all finished spaces and may be installed exposed or concealed in all process spaces. Raceways installed exposed shall be near the ceiling or along walls of the areas through which they pass and shall be routed to avoid conflicts with HVAC ducts, cranes hoists, monorails, equipment hatches, doors, windows, etc.

J. Modifications or Substitution of Equipment

1. Where a specific material or equipment is listed in the Specifications or on the Drawings, it is understood and construed as meaning to indicate a standard of quality. Unless specifically noted otherwise, such listing is not intended in any way to bar the use of any material or equipment that is of equal or better quality.

2. The Electrical Drawings have been prepared on the basis of the equipment first named in the Specifications. The Contractor shall note that the second named equipment, if given, is considered acceptable and equal equipment, but in some cases additional work or material may be required to accommodate the second named equipment into the project. The Contractor desiring to use the second named equipment or any equal equipment is responsible for all costs, including cost of any engineering, material, or installation, incurred by using other than the first named equipment.

3. Likewise, redesign of electrical or mechanical work, which is required due to the Contractor's use of an alternate item, arrangement of equipment and/or layout other than that shown on the Contract Documents, shall be performed at the Contractor's expense. Contractor shall pay for all such changes including protective devices, bus ratings, conduit, wire, building modifications, etc.

4. Contractor shall be responsible for preparing any required engineering documents specified under Division 16. Where indicated, submit documents stamped and signed by a Professional Electrical Engineer currently registered in the State of California.

5. Changes from the layout shown to facilitate use of alternate equipment shall not be a basis for additional payment; neither shall changes in electrical controls or wiring or piping caused by the use of second named or equal equipment be a basis for additional payment.

1.6 PROJECT/SITE REQUIREMENTS

A. Elevation: Equipment shall be designed to operate at a ground elevation of approximately 75 feet above mean sea level.

B. Temperature:

1. Equipment located in exterior locations shall be suitable for operation at temperatures from +12° to +45° C degrees ambient.

2. Equipment located in internal areas shall be suitable for operation:

a. In conditioned spaces from +15° to +30° C degrees ambient.

b. In unconditioned spaces from +15° to +45° C degrees ambient

3. Were applicable, equipment shall be rated for extended storage temperatures ranges from +12° to +45° C degrees ambient.

C. Relative Humidity: Equipment located in conditioned spaces shall be suitable for 0 to 80 percent relative, non-condensing humidity. All other equipment shall be suitable for 0 to 100 percent relative, condensing humidity.

D. Provide equipment and devices suitable for continuous operation at the temperatures and elevations at the site and at the facility installation locations shown on the Drawings.

1. Provide equipment capable of continuous operation at the required rated output shown on the Contract Documents at the specified site conditions.

2. Provide any additional equipment such as passive thermal cooling, insulation, sunshades, heating, cooling equipment, or other means so that the rated performance requirements can be met. Such equipment shall be provided at no additional cost to the City.

3. Provide suitability derated equipment if required based on the site conditions. Derated equipment shall be provided with revised manufacturer’s nameplates stating the equipment rating for continuous duty and the environmental conditions upon which the continuous rating applies. Deration of equipment shall only be

allowed if the derated equipment rating conforms to the required equipment ratings as shown on the Contract Documents.

4. Provide supplementary equipment deration if required for both ambient temperature extremes and elevation as required by the manufacturer.

1.7 ENCLOSURE TYPES

A. Unless otherwise indicated in the Contract Documents, electrical enclosures, conduit systems, and electrical installations shall conform to the following ratings:

1. NEMA 1: indoor, above grade locations subject to clean, dry, and non-process conditions including but not limited to:

a. Administration areas

b. Office areas

c. Dedicated conditioned electrical rooms

d. Laboratories

e. Control rooms

2. NEMA 12: indoor, above grade locations subject to non-corrosive, dry or damp process areas, or dusty conditions including but not limited to:

a. Dedicated non-conditioned electrical rooms

b. HVAC equipment rooms

c. Process mechanical equipment rooms

d. Maintenance shops

3. NEMA 3R: outdoor locations not subject to hose-down conditions

4. NEMA 4: outdoor locations, below grade structures, and indoor locations subject to non-corrosive, wet, or dirty conditions including but not limited to:

a. Outdoor facilities subject to hose-down conditions

b. Process mechanical equipment rooms

c. Basements

d. Buried vaults

e. Below grade process facilities

f. Other hose down areas

g. Non-corrosive process treatment basins, tanks, or vessels.

5. NEMA 4X: locations subject to corrosive or marine conditions including but not limited to:

   a. Process mechanical equipment rooms

   b. Chemical feed or storage areas

   c. Wastewater treatment areas

   d. Wastewater or other corrosive process treatment areas (basins, tanks, or vessels)

6. NEMA 7: locations in hazardous classified indoor locations as shown on the Drawings and as required per the NEC and NFPA 820.

7. NEMA 7 (gasketted) in hazardous classified outdoor locations as shown on the Drawings and as required per the NEC and NFPA 820.

1.8 UTILITY SERVICE AND METERING

A. General: Work under this Contract includes conversion of the existing 480 volt PG&E service to a new 21kV service and modification of the existing facility photovoltaic installation as shown on the Drawings and as specified.

B. Costs for PG&E engineering, equipment, and installation shall be borne by the City.

C. Electrical Power Utility

1. The Electrical Utility serving this facility is the Pacific Gas & Electric Company. Utility contact information is as follows:

   Pacific Gas & Electric Company
   Nicholas Souza
   415-695-3274
   njsc@pge.com

2. The Utility Company will be providing the electrical service to the facility. The following information, equipment, and installation will be provided by the Utility Company:

   a. Furnishing site layout design drawings for the utility improvements.

   b. Furnishing and installing the 21 kV primary underground conductors and associated modifications.

   c. Furnishing and installing riser poles, primary cutouts, lightning arresters and grounding of power company equipment in conformance with power company requirements.

   d. Furnishing and installing the utility subsurface or padmounted primary equipment (switches, etc.) as shown on the Drawings or as required by PG&E.

e. Termination of underground primary cables including termination at power company equipment, at riser poles, and on the line side of the utility disconnecting means.

f. Splicing or tapping of utility conductors as required.

g. Demolition of existing utility primary overhead lines, underground lines, transformers, metering equipment, capacitors, and other power company equipment removed from service under this Contract.

3. The Contractor shall provide the following:

a. Attendance at a minimum of two, four hour coordination meetings with PG&E for the work at the site. Meetings will be held at the WWTP site and coordinated by the Construction Manager at times to be determined.

b. Submit shop drawings to the power company for site engineering and equipment and protective device review and approval per the requirements of Section 16240 and 16350. Work on project elements associated with utility service shall not commence until an approved set of utility engineering documents have been received.

c. Submit grounding details for power company facilities and infrastructure as specified in Section 16060.

d. Coordinate work to be performed by PG&E as part of the overall Project construction schedule as specified in Section 01310.

e. All utility service and grounding work shall be subject to review and inspection by the power company. Coordinate power company inspections of applicable work performed by the Contractor.

f. Furnishing and installing primary interface conduits and subsurface pulling structures to locations indicated on Drawings or for conduits entering existing power company structures and equipment.

g. Furnish and install a power company approved primary metering enclosure and components as specified in Section 16350.

h. Provide conduit risers, underground pull structures, underground equipment vaults, pads, grounding systems, relaying, metering, and other equipment as shown on the Drawing and in conformance with PG&E service requirements.

i. Furnish all other labor and material required for the electrical service work not performed by PG&E.

D. Coordination

1. Contractor shall provide all coordination with Utility Company and coordinate necessary shutdowns with the City. Refer to Section 01010.

2. Submit equipment data as required for Medium Voltage Switchgear per Section 16350, Station Batteries per Section 16240, and as required by PG&E interconnection requirements. Submittals to the utility shall only be made following favorable review of the equipment submittals by the Engineer.

3. The Contractor shall schedule and hold two mandatory PG&E coordination meetings during construction. The meetings shall include as a minimum the Owner's representative, the Contractor, PG&E, and the electrical subcontractor. Other attendees shall be invited based on the specific requirements of the meeting. All meetings will be held at the WWTP site.

   a. Prepare and distribute an agenda for each meeting a minimum of one week before the scheduled meeting date for review and comment by the Owner. Each meeting will last up to four (4) hours total length. Facilitate the meetings and submit draft meeting minutes for review by the Owner followed by final meeting minutes incorporating review comments and distribution to all attendees. Contractor shall be responsible for coordinating attendance of all non-City personnel including all Contractor staff and utility representatives.

   b. Meeting 1 – Project Kickoff Meeting: The meeting shall be held no less than 30 calendar days following Notice To Proceed. The purpose of the meeting shall be to introduce the project to all parties, establish communication links between the Contractor and other entities, and provide means for requesting any additional information. Meeting shall be attended at a minimum by the group identified. At the meeting, the Contractor shall summarize understanding of the project; describe proposed equipment; discuss any proposed substitutions, deviations, or alternatives to the Contract Documents; present a preliminary Project Schedule showing key project elements and milestone dates, and request any additional information required from the Owner.

   c. Meeting 2 – 21 KV Primary Service Switchover Coordination Meeting: The meeting shall be held no less than 30 calendar days prior to the planned primary service switchover date but nor before receipt of favorable review of the switchgear lineup and other equipment by PG&E (refer to Section 16350). Meeting shall be attended at a minimum by the group identified above and include the medium voltage switchgear supplier. The purpose of the meeting shall be to review status of PG&E site work and infrastructure improvements; proposed sequence of the service switchover; City operation during switchover, Contractor switchover contingency plans; and equipment testing and inspection schedule by the Contractor and PG&E.

E. Testing: Perform witness testing of protective devices with utility representatives present per utility standards for confirmation of utility requirements prior to energization of new utility service. Utility witness testing shall be scheduled and coordinated by the Contractor with the utility and the construction schedule for the new service work. Testing shall follow procedures and guidelines for protective devices, relays, battery systems, and other equipment as documented in utility standard practices.

1.9 PHOTOVOLTAIC SYSTEM MODIFICATIONS

A. General: Work under this Contract includes conversion of the existing 480 volt photovoltaic connection at the plant main service as shown on the Drawings and as specified.

B. Photovoltaic System Supplier:

1. The Photovoltaic System Operator serving this facility is Tesla Energy (SolarCity). Contact information is as follows:

   Tesla Energy
   Leo Wu, P.E.
   Senior Electrical Engineer
   3055 Clearview Way
   San Mateo, CA
   650-963-5820
   leowu@tesla.com

C. The Photovoltaic System Operator will perform the following work:

1. Disconnect or otherwise ensure de-energization of the photovoltaic system from the plant main distribution to allow the Contractor to proceed with the system modifications as shown on the Drawings.

2. Coordinate with PG&E and disconnect and disconnect or otherwise ensure de-energization of the photovoltaic system from the plant main distribution to allow PG&E to proceed with the system modifications as shown on the Drawings.

D. Coordination

1. The Contractor shall schedule and hold one mandatory PG&E and Photovoltaic System Operator coordination meeting. The meetings shall include as a minimum the Owner's representative, Photovoltaic System Operator, the Contractor, PG&E, and the electrical subcontractor. Other attendees shall be invited based on the specific requirements of the meeting. All meetings will be held at the WWTP site.

2. Prepare and distribute an agenda for each meeting a minimum of one week before the scheduled meeting date for review and comment by the Owner. Each meeting will last up to four (4) hours total length. Facilitate the meetings and submit draft meeting minutes for review by the Owner followed by final meeting minutes incorporating review comments and distribution to all attendees. Contractor shall be responsible for coordinating attendance of all non-City personnel including all Contractor staff and utility representatives.

3. The meeting shall be held no less than 30 calendar days prior to the planned primary service switchover date but nor before receipt of favorable review of the switchgear lineup and other equipment by PG&E (refer to Section 16350). The purpose of the meeting shall be to review status of PG&E site work and infrastructure improvements and coordinate switchover details with the Photovoltaic System Operator.

1.10 HANDLING AND SIZE OF EQUIPMENT

A. Investigate each route at the facility through which electrical equipment must pass to reach its final installed location. Coordinate shipping splits with the manufacturer to permit safe handling and passage through restricted areas in the facility and within structures.

B. The equipment shall be kept upright at all times during storage and handling. Should the equipment require tilting for passage through restricted height areas, brace the equipment to insure that the tilting does not impair the structural or functional integrity of the equipment.

1.11 MAINTENANCE

A. Spare Parts

1. Spare parts shall be in accordance with Section 01750 and as defined in the related technical specification sections. All spare parts shall be new and unused, provided in original packaging.

2. All spare parts shall be individually packaged and labeled with the part designation and the associated end use equipment tag designation as shown on the Contract Documents.

3. Provide one pint of touch-up paint, in one-quart containers for each type and color used for all cabinets, panels, consoles, etc., supplied under the related specification sections.

4. The spares listed above shall be packed in a manner suitable for long-term storage and shall be adequately protected against corrosion, humidity and temperature.

1.12 RECORD DRAWINGS

A. As the work progresses, clearly and legibly record all field changes on a set of project contract drawings, hereinafter called the "record drawings set". Record drawing set shall conform to the requirements of General Conditions.

B. Record drawing set shall be kept at the job site and readily available for review by the City or the Engineer.

C. Record drawings shall be updated daily by the Contractor to provide an accurate record of the current condition of the work.

D. Record drawing set shall accurately show the installed condition of the completed project. The record drawing set shall accurately document the final locations and conditions of the following items:

1. One-line Diagrams

2. Raceways and pull boxes

3. Conductor sizes and conduit fills

4. Lighting and distribution panelboard Schedules

5. Control wiring diagrams

6. Lighting fixtures, receptacles, and switches

7. Contractor prepared raceway layout drawings

8. Underground electrical system raceway and duct bank routing shown on the plan drawings. Routing shall include final installation depths below finished grade. Final locations of handholes and manholes shall be documented using the project coordinate system.

9. Plan views of switchboards, distribution transformers, substations, motor control centers and panelboards; include dimensioned outline of final installed location of the equipment.

10. Grounding system including location of ground rods and routing of grounding electrode conductors and ground grid components.

PART 2 PRODUCTS

2.1 GENERAL

A. Where two or more units of the same class of material or equipment are required, provide products of a single manufacturer.

B. Unless otherwise indicated, provide materials and equipment which are the standard products of manufacturers regularly engaged in the production of such materials and equipment. Provide the manufacturers' latest standard design that conforms to these Specifications.

2.2 ANCHORING AND SEISMIC REQUIREMENTS

A. General: All anchorage systems to be furnished under this contract shall be designed, constructed, and installed in conformance with the seismic requirements of Section 01612 and 01614.

B. Provide equipment seismically certified for application at the Project site where specifically called for in other Sections of Division 16.

2.3 EQUIPMENT IDENTIFICATION

A. Identify all equipment, disconnect switches, separately mounted motor starters, control stations, etc. furnished under Division 16 with the name of the equipment it serves unless otherwise noted. Motor control centers, control panels, panelboards, switchboards, switchgear, junction or terminal boxes, transfer switches, etc., shall have nameplate designations as shown on the Drawings.

B. Nameplates shall be engraved, laminated plastic, not less than 1/16-in thick by 3/4-in by 2-1/2-in with 3/16-in high white letters on a black background.

C. Edges of the nameplates shall be beveled and smooth. Nameplates with chipped or rough edges will not be acceptable.

2.4 MARKINGS AND EQUIPMENT WARNING SIGNS

A. Electrical Safety and Working Clearance Identification

1. Provide a painted outline about electrical equipment to identify areas that are to be kept clear of storage and debris. The painted outline shall consist of a 3 inch wide, neatly painted line, utilizing safety yellow paint appropriate for the surface being painted.

2. The nearest edge of the line shall be 72-inches in front of electrical equipment rated above 600V and 48 inches in front of electrical equipment rated 600V and lower. Line shall extend to the edge of the equipment or 15 inches from the centerline of the equipment, whichever is greater.

3. Provide electrical switchboard electro-static matting in front, and rear when accessible from the rear, of electrical equipment. The matting shall be the minimum size specified, and extend to the edge of the yellow safety outline at the sides of the equipment. Matting shall conform to the requirements of Section 16191.

B. Provide arc flash warning labels on electrical power distribution equipment per Section 16080.

C. Provide high voltage warning labels and signage on electrical power distribution equipment in conformance with OSHA

D. Permanent warning labels shall be mounted at all mechanical equipment which may be started automatically or from remote locations. Labels shall be in accordance with OSHA regulations for personnel safety and shall be suitable for exterior use. The warning labels shall be self-adhesive or fastened with stainless steel screws or bolts as required by the equipment mounting surface. Locate and mount labels as approved by the Engineer. Warning sign shall display the following:

CAUTION
THIS EQUIPMENT STARTS
AUTOMATICALLY
BY REMOTE CONTROL

E. Permanent warning labels shall be mounted at all electrical equipment enclosures where a voltage sourced from outside the enclosure is present. Labels shall be yellow colored Lamicoid or equal material, engraved with a minimum ¼" lettering mounted on the front exterior of the panel approximately 5' above finished floor or grade. The warning labels shall be self-adhesive or fastened with stainless steel screws or bolts as required by the equipment mounting surface. Locate and mount labels as approved by the Engineer. Warning sign shall display the following:

CAUTION
FOREIGN VOLTAGES
PRESENT

2.5 FASTENERS

A. Fasteners and anchors for securing equipment to walls and floors shall be either hot dip galvanized after fabrication or stainless steel unless noted otherwise.

PART 3 EXECUTION

3.1 GENERAL

A. Unless specified otherwise, electrical equipment and anchoring systems shall be designed to withstand seismic forces as specified in Section 01612.

B. Install materials and equipment in a workmanlike manner utilizing craftsmen skilled in the particular trade and conforming to standards of the industry. Provide work which has a neat and finished appearance. Carry out work in accordance with NECA Standard of Installation unless otherwise shown in the Contract Documents.

C. Coordinate electrical work with the Engineer and work of other trades to avoid conflicts, errors, delays, and unnecessary interference with operation of the plant during construction.

D. Check the approximate locations of light fixtures, electrical outlets, equipment, and other electrical system components shown on Drawings for conflicts with openings, structural members, and components of other systems and equipment having fixed locations. In the event of conflicts, notify the Engineer in writing. The Engineer's decision shall govern. Make modifications and changes required to correct conflicts.

E. Follow manufacturers' installation instructions explicitly, unless otherwise indicated on the Contract Documents. Wherever any conflict arises between the manufacturers' instructions, codes and regulations, and these Contract Documents, follow Engineer's direction. Keep copy of manufacturers' installation instructions on the jobsite available for review at all times.

3.2 PROTECTION DURING CONSTRUCTION

A. Throughout this Contract, provide protection for materials and equipment against loss or damage in accordance with provisions elsewhere in these Contract Documents. Throughout this Contract, follow manufacturers' recommendations for storage. Protect all equipment from the effects of weather.

B. Prior to installation, store items in clean, dry, indoor, or other locations suitably protected from the elements. Energize all integral equipment space heaters with temporary power as required. Provide temporary heating devices, sufficient to prevent condensation, for all other electrical equipment that does not have space heaters.

C. Following installation, protect materials and equipment from corrosion, physical damage, and the effects of moisture on insulation. When equipment intended for indoor installation is installed at the Contractor's convenience in areas where it is subject to dampness, moisture, dirt, or other adverse atmosphere until completion of construction, ensure that adequate protection from these atmospheres is provided. Such protection methods shall be approved by the Engineer.

D. Cap all conduit runs during construction with manufactured seals until installation of conductors is required. Keep openings in boxes or equipment closed during construction.

3.3 SERVICE CONTINUITY

A. Maintain continuity of electric service to all functioning portions of the plant. Make no outages without prior written authorization of the Engineer. Include all costs for temporary wiring and overtime work required in the Contract price as required to meet the Project constraints defined in Division 1. Remove all temporary wiring at the completion of the work.

B. Provide temporary electric power used during construction including the use of standby generators for continuous operation as needed as required under Section 01010.

3.4 EQUIPMENT IDENTIFICATION

A. Provide identification nameplates for all electrical and instrumentation equipment provided under this Contract.

B. Provide nameplate with designations as shown on the Drawings and as specified in Section 16075.

3.5 EQUIPMENT SUPPORTS

A. Provide equipment supports for all equipment in accordance with the mounting and anchorage requirements of Section 01612 and per manufactures requirements.

B. Installation of equipment shall not proceed until mounting and anchoring calculations have been submitted and approved.

C. Free standing panels and enclosures shall be mounted on concrete pads having plan dimensions shown on the Drawings or larger if required by the mounting and anchorage calculations.

3.6 SLEEVES AND FORMS FOR OPENINGS

A. Provide and place all sleeves for conduits penetrating floors, walls, partitions, etc. Locate all slots for electrical work and form before concrete is poured.

B. Identify precise locations for stubbing-up and terminating concealed conduit prior to commencing conduit layout work. Obtain shop drawings and templates from equipment vendors or other subcontractors and properly locate the concealed conduit before the floor slab is poured.

C. Where setting drawings are not available in time to avoid delay in scheduled floor slab pours, the Engineer may allow the installations of such conduit to be exposed. Requests for this deviation must be submitted in writing. No additional compensation for such change will be allowed.

D. Seal all openings, sleeves, penetration, and slots as specified in Section 16130.

3.7 CUTTING AND PATCHING

A. Lay out work carefully in advance. Do not cut, drill, or notch any structural member or building surface without specific approval of Engineer. Carefully carry out any cutting, channeling, chasing, or drilling of floors, walls, partitions, ceilings, paving, or other surfaces required for the installation, support, or anchorage of conduit, raceways, or other electrical materials and equipment.

B. Following cutting and patching work, restore surfaces to original finished condition. Include all patching and painting of the surfaces to match original. Use skilled craftsmen of the trades involved.

3.8 LOAD BALANCE

A. The Drawings and Specifications indicate circuiting to electrical loads and distribution equipment. Balance electrical load between phases as nearly as possible on lighting and distribution panelboards, etc. based on the load requirements of the actual equipment provided under this Contract.

3.9 TESTS

A. Perform testing as specified in Section 16080.

3.10 CLEANUP AND PAINTING

A. The Contractor shall be responsible for the removal and legal disposal of all debris and unused equipment which he introduces to the project site during the execution of the Contract.

B. Painting shall be in accordance with Section 09900. Unpainted boxes, cabinets, and raceways mounted on walls that are painted or to be painted shall be painted the same color as the walls.

C. Keep the premises free from accumulation of waste material or rubbish. Upon completion of work, remove all materials, scraps, and debris from premises and from interior and exterior of all devices and equipment.

D. Touch up scratches, scrapes, or chips in interior and exterior surfaces of devices and equipment with finishes matching as nearly as possible the type, color, consistency, and type of surface of the original finish. If extensive damage is done to equipment paint surfaces, refinish the entire equipment in a manner that provides a finish equal to or better than the factory finish, that meets the requirements of the Specifications, and that is acceptable to the Engineer.

E. The interior of all electrical equipment, including windings of dry type transformers, shall be vacuumed and wiped free of dust, metal filings, and other debris. Cleaning shall be done prior to energization and again immediately before final inspection. De-energization of any equipment that is required to allow panel cleaning shall be approved in writing by the Engineer.

F. Refer to Section 01710 and the individual equipment technical specifications of Division 16 for additional requirements.

3.11 MANUFACTURER’S SERVICE AND TRAINING

A. Provide manufacturer's services for equipment installation, startup, and testing. Provide training of plant personnel in operation and maintenance of the equipment furnished under other Sections of Division 16 and as specified in Section 01660.

3.12 INSPECTION

A. Allow materials, equipment, and workmanship to be inspected at any time by the Engineer and City or their representatives. Correct work, materials, or equipment not in accordance with these Contract Documents or found to be deficient or defective in a manner satisfactory to the Engineer.

B. Before request for final inspection is made, the Contractor shall submit to the Construction Manager, in writing, a certificate stating that the Contractor has made his own thorough inspection of the entire project and that the installation is completed and in conformance with the applicable codes, and the contract plans and specifications.

END OF SECTION

SECTION 16002 – ELECTRICAL AND INSTRUMENTATION DEMOLITION AND MODIFICATIONS

PART 1 GENERAL

1.1 SCOPE OF WORK

A. Section Includes: All labor, materials, and incidentals required to demolish, modify and/or remove the electrical and instrumentation systems and equipment as shown on the Drawings and/or specified herein. Unless specifically noted as being reused, all conduit, wire, boxes, etc. detailed on the Drawings shall be new equipment installed under this Work.

B. The project work associated with demolition and removal shall be performed in several phases. Demolition and sequencing of the electrical elements of work shall be coordinated with the overall sequence as described in Section 01010 and site civil demolition as specified under Section 02050.

C. The electrical modifications and removals work shall generally consist of the following:

1. Any electrically powered or controlled equipment indicated as being removed in this Contract and associated electrical appurtenances.

2. Existing electrical equipment or electrical equipment associated with mechanical or process equipment which must be removed or relocated due to conflicts with new construction.

3. Electrical control devices, starters, wiring, and other miscellaneous devices associated with equipment that will be modified or reused under this Contract.

4. Instrumentation and control equipment and related conduit and wire associated with equipment being modified or removed under this Contract.

1.2 RELATED WORK

A. Section 01010 – Summary of Work

B. Section 01600 – Material and Equipment

C. Section 02050 – Demolition and Reconstruction

D. Section 02081 – Hazardous Materials Abatement

E. Section 16000 – Common Work Results for Electrical

1.3 SUBMITTALS

A. Submit in accordance with Sections 01340 and 16000.

B. Submit detailed time schedule for equipment which will be either modified or removed under this Work. Include details of work to be done, anticipated duration of the work, impact of the work on plant operations, and coordination with other trades, per the requirements of the overall project schedule per Section 01310.

C. All modifications made to existing Switchgear, MCCs, and other panels shall be fully described in shop drawing submittals. The submittals shall include the following as a minimum:

1. Panel elevation drawings clearly and unambiguously identifying the specific equipment that will be removed.

2. Revised panel wiring diagrams clearly and unambiguously indicating the specific modifications to the equipment internal and external circuiting of the new or modified devices.

3. Technical details and catalog cut sheets for the new equipment including electrical characteristics, physical sizing, and installation requirements.

4. Revised enclosure or housing dimensioned plan and elevation drawings clearly and unambiguously indicating the required alterations to the enclosure physical dimensions and characteristics.

5. Engraving schedule and details for all new nameplates, escutcheon plates, and equipment tagging.

PART 2 PRODUCTS (NOT USED)

PART 3 EXECUTION

3.1 MODIFICATIONS

A. All MCCs, switchboards, switchgears and other panels requiring modification under this Work shall comply with the following general requirements:

1. Equipment removed from service shall have suitable metallic covers placed over any unused exterior panel holes. Covers shall be painted to match the existing panel and shall be securely retained on the panel with stainless steel machine screws, nuts, and other hardware.

2. Newly installed equipment shall be mounted, connected, and identified consistent with the other equipment in or on the panel. Nameplates shall also be provided for all new equipment mounted on the exterior of existing panels. At motor control centers, provide nameplates matching existing including nameplates for “SPARE” devices created by work under this Contract. Conform to the nameplate requirements of Section 16000.

3. In lighting and distribution panels, the circuit card or listing shall be replaced with a newly typed, comprehensive circuit card showing the as-left condition (i.e. both changed and unchanged circuits) of the panel.

4. All modifications made to panels shall be retrofit with components furnished by the original panel manufacturer to maintain all original UL and NEMA labeling and certifications. Devices installed in compartmentalized panels shall be provided with new doors and interior mounting pans as required to match the existing panel construction style and enclosure environmental ratings.

5. Mounting holes required for new equipment shall be neatly cut and deburred. Take care to mitigate deposits of metal cuttings deposited inside of the modified panel.

6. Interior panel wiring for newly added devices shall match the existing panel wiring type, mounting, and identification scheme.

3.2 EQUIPMENT TO BE REMOVED

A. Electrical and instrumentation equipment to be removed are not specifically shown or noted on the Drawings. Failure to detail all equipment removal requirements exactly shall not relieve the Contractor from the responsibility for its removal as implied on other site demolition Drawings or as directed by the Engineer. Removal items such as individual wire, conduit, junction boxes, etc. are in general not detailed on the Drawings.

B. Where removal of electrical, instrumentation, or any other equipment including but not limited to process mechanical, irrigation, and HVAC equipment with wired connections is called for, include the removal of the associated electrical hardware as specified herein unless noted otherwise.

C. In general, all conductors shall be removed from the conduits; boxes and fittings and all exposed conduit shall be removed to the point of termination. Concealed conduits shall be cut flush with the floor, wall, or ceiling and plugged with non-shrink grout or other permanent material and as detailed on the Drawings.

D. Electrical power, control, or instrumentation equipment, exposed conduit, wiring, etc. rendered inoperative by modifications to existing equipment under these Contract Documents shall be removed unless specifically noted that it is to be abandoned in place.

E. Not all existing conduits are shown on the Drawings. In general, existing conduits are shown only where they may be reused; or where they potentially affect or may be affected by new work under this Contract; or for providing useful background information to the Contractor regarding the existing electrical installation.

F. Where existing conduit or wire associated with removed equipment is to be reused, it will be specifically noted on the Drawings. Where portions of an existing conduit route to be reused (including buried or embedded portions) is clearly required to be removed or relocated due to new construction, it shall be included in work under this Contract even if not specifically detailed or noted as such on the Drawings.

G. No existing conduits, wiring, or electrical appurtenances shall be removed, modified, or in any way damaged unless allowed by the provisions of this Section. Any existing conduits, conductors, or other electrical appurtenances that are encountered as an obstruction to new construction which are not covered by the provisions of the Contract Documents shall be brought to the attention of the Engineer.

H. Where functions of existing cables and/or conduits are replaced by new cable and/or conduits because of additions of new panels, instruments, revision to control strategy, etc., the existing cables and exposed conduits shall be removed unless noted otherwise. Concealed conduits shall be retained and marked as spares unless noted otherwise.

I. Equipment removed shall not be reused under this Contract unless specifically noted on the Drawings or Specifications.

J. To minimize disruptions to the existing plant operations, the schedule for modifications and removal of existing equipment shall be submitted to, coordinated with, and approved by the Engineer.

K. Where any existing circuits are disconnected due to abandonment or removal of existing equipment, the remaining motor starters or circuit breakers for these circuits shall be retagged as spares.

3.3 CIRCUIT RELOCATION

A. Prior to relocation of circuits as required the Contractor shall trace all wires from the source to the destination. The wires shall be tagged to include an identification number as specified in Section 16000. The Contractor shall provide all testing equipment and hardware necessary to gain access and locate circuits to determine their source and origin. The conduit schedules provided in the Contract Documents were developed based on available asbuilt documents and site investigations during design, however, the Contractor shall provide field verification of the conduits including their circuits prior to relocation.

B. For underground ductbanks the Contractor shall trace and pot hole around the area of work to field locate the approximate location of the ductbanks prior to excavation. The Contractor shall hand dig around the electrical ductbank to expose a section of the duct for access. Access to existing circuits located in existing reinforced concrete ductbanks shall include chipping away of the concrete envelope as necessary to expose rebar prior to cutting or torching to allow access to the conduits. Once the conduits are exposed the Contractor shall carefully cut the conduit to access the conductors for circuit verification, reconnection, and/or reinstallation as detailed on the Drawings. Contractor shall use the utmost care to expose circuit conductors within existing concrete ductbanks without damaging the conductor insulation where indicated for reuse.

C. Excess slack conductor length shall be maintained where required to reuse the existing conductor for termination at a Terminal Junction Box where shown on the Drawings. Provide a minimum of 10-feet slack conductor length unless noted otherwise on the Drawings.

D. Where new conductors are replacing existing conductors in existing ductbanks the ducts/conduits shall be swabbed clean and mandreled prior to installation of the new conductors.

E. Where existing ductanks are to remain in place and conduits become “Spares” or “Empty” the Contractor shall provide a polyethylene pull rope as specified in Section 16600.

3.4 DEMOLITION

A. The Contractor shall survey the existing electrical systems and equipment identified for removal with representatives from the other trades and the Engineer prior to performing any demolition work. Prior to removal, identify all conduit and equipment to be removed with tags or paint. Equipment to be removed shall be identified a minimum of three (3) weeks before demolition is scheduled to allow sufficient review time by the Engineer for possible salvage.

B. Remove all electrical work associated with equipment scheduled for demolition except those portions indicated to remain or be reused. Where a piece of equipment is to be removed, all associated ancillary components (e.g. seal water solenoid valves, pressure switches, etc.) and associated wiring and conduit shall also be removed.

C. Building or structures scheduled for complete demolition shall be made safe from electrical shock hazard prior to demolition. Disconnect all electrical power, communications, alarm and signal systems included in the demolished structure.

D. Remove exposed conduit and conductors to be demolished back to the point of concealment including abandoned conduit above accessible ceiling finishes. Completely remove demolished conductors in concealed conduits back to the source or nearest point of maintained usage.

E. Disconnect abandoned outlets and remove devices. Remove abandoned outlets if conduit servicing them is abandoned and removed. Provide blank covers per Section 16000 for abandoned outlet boxes which are not removed.

F. Disconnect and remove abandoned panelboards, disconnect switches, control stations, distribution equipment, etc.

G. Disconnect and remove abandoned lighting fixtures. Remove brackets, stems, hangers and other accessories. Repair adjacent construction and finishes damaged during demolition and extension work. Paint areas of equipment and hardware removal in conformance with Division 9.

H. Where electrical systems pass through the demolition areas to serve other portions of the premises, they shall remain or be suitably relocated and the system restored to normal operation.

I. Coordinate outages in systems with the Engineer in accordance with Section 01010. Where duration of proposed outages cannot be allowed by the requirements of the Contract Documents provide temporary connections or power sources as required to maintain service.

J. Trace out existing wiring that is to be relocated or removed and perform the relocation or removal work as required for a complete operating and safe system.

K. Continuous service is required on all circuits and outlets affected by these changes, except where the Engineer will permit an outage for a specific time as defined in the Contract Documents. Obtain the approval of the Engineer before removing any circuit from continuous service.

L. Remove exposed conduits, wireways, outlet boxes, pull boxes, and hangers abandoned or made obsolete by the alterations, unless specifically designated to remain. Patch surfaces and repaint as specified under Section 09900.

M. All equipment, materials, controls, motor starters, branch and feeder breakers, panelboards, transformers, wiring, raceways, etc., furnished and installed to temporarily keep circuits energized shall be removed when the permanent installation is fully operational. Any surfaces or finishes damaged by the temporary installations shall be returned to its condition prior to the commencement of the work.

3.5 DISPOSITION OF REMOVED MATERIALS AND EQUIPMENT

A. Refer to Section 01600 for removed items to be retained by the City.

B. In general, all the material and equipment indicated to be removed and disposed of by the Contractor shall, upon removal, become the Contractor's property and shall be properly disposed of off the site by the Contractor, unless otherwise directed by the Engineer. A receipt showing acceptable disposal of any legally regulated materials or equipment shall be submitted to the Engineer.

C. Fluorescent Fixture Disposal: Existing fluorescent bulbs removed under this Contract shall be assumed to contain mercury and disposed of per Section 02081.

D. PCB Disposal

1. Ballasts in each existing lighting fixture shall be assumed to contain PCB's unless specifically marked with a label indicating "No PCBs" and disposed of per Section 02081 and as specified below.

2. All equipment containing PCBs or equipment contaminated by PCBs shall be removed, packaged, shipped and disposed of in accordance with all applicable State and Federal regulations. Provide the services of a firm licensed and regularly engaged in the removal of PCBs and PCB contaminated equipment. The firm shall be licensed in the State or States in which the contaminated material is handled, shipped and disposed. Include all fees associated with the removal, packaging, shipping, and disposal of the contaminated material and equipment in the Contract Bid Price. Submit documentation to the Engineer showing acceptable disposal.

3. Should PCB contaminated equipment be discovered that was not identified in the Contract Documents, cease work on or about the equipment and notify the Engineer immediately. The Contractor shall then proceed with the work as directed by the Engineer.

END OF SECTION

SECTION 16060 – GROUNDING AND BONDING FOR ELECTRICAL SYSTEMS

PART 1 GENERAL

1.1 DESCRIPTION

A. Work included:

1. Furnish all labor, materials, equipment and incidentals required and install a complete grounding system in strict accordance with Article 250 of the NEC, as shown on the Drawings and as specified herein.

2. All raceways, conduits and ducts shall contain equipment grounding conductors sized in accordance with the NEC. Minimum sizes shall be No. 12 AWG.

3. Provide grounding bus bars where shown on the Drawings.

4. Connect all hatches, metal stairs and handrails to system ground grid or system ground loop.

5. Grounding of internal components of packaged process system provided under other technical sections shall include grounding connections internal to and between components of the system as recommended by the Supplier or as required by the NEC or other NFPA requirements. Coordinate grounding of packaged equipment with the packaged system supplier(s). Provide equipment grounding conductors in raceways carrying equipment supply feeders and bond individual packaged system components to the ground grid system as shown on the Drawings and specified herein.

1.2 RELATED SECTIONS

A. Section 16000 – Common Work Results for Electrical.

B. Section 16080 – Electrical System Analyses and Acceptance Testing.

C. Section 16130 – Raceways and Boxes for Electrical Systems.

1.3 SUBMITTALS

A. Submittals shall be made in accordance with Section 01340 and Section 16000.

B. Submit product data for the following:

1. Ground rods.

2. Ground rod boxes.

3. Exothermic welding materials and methods.

4. Mechanical and compression type grounding clamps including installation requirements and materials.

5. Grounding hubs and fittings.

6. Grounding bars

C. Submit results of grounding and bonding resistance testing as specified herein

1.4 REFERENCES

A. American National Standards Institute (ANSI)/ Institute of Electrical and Electronics Engineers (IEEE).

1. IEEE Std 142 – IEEE Recommended Practice for Grounding of Industrial and Commercial Power Systems.

2. IEEE Std 837 – IEEE Standard for Qualifying Permanent Connections used in Substation Grounding

B. American National Standards Institute (ANSI)/National Science Foundation (NSF)

1. ANSI/NSF 60 – Drinking Water Treatment Chemicals – Health Effects

C. American Society for Testing and Materials (ASTM).

1. ASTM B 3 – Standard Specification for Soft or Annealed Copper Wire.

2. ASTM B 187 – Standard Specification for Copper Bar, Bus Bar, Rod, and Shapes.

3. ASTM B 8 – Standard Specification for Concentric-Lay-Stranded Copper Conductors, Hard, Medium-Hard, or Soft.

D. California Code of Regulations.

1. Title 24, Part 3 – California Electrical Code (NEC), Article 250 (Grounding).

E. Underwriters Laboratories (UL).

1. UL 467 – UL Standard for Grounding and Bonding Equipment.

2. UL 224 – UL Standard for Extruded Insulating Tubing.

F. InterNational Electrical Testing Association (NETA).

1. ATS – Acceptance Testing Specifications for Electrical Power Distribution Equipment and Systems.

G. Where reference is made to one of the above standards, the revision in effect at the time of bid opening shall apply.

1.5 QUALITY ASSURANCE

A. All grounding and bonding products shall be UL listed.

B. All exothermically welded or compression-type terminal lugs for buried or embedded connections shall use materials qualified in accordance with IEEE 837.

PART 2 PRODUCTS

2.1 GENERAL

A. Direct-buried, concrete encased, and exposed grounding conductors.

1. Bare concentric stranded copper conductors conforming to ASTM B-8 with Class B stranding, size as indicated on the Drawings.

2. Acceptable manufactures:

a. Southwire

b. General Cable

c. Approved equal

B. Ground rods

1. 3/4 in by 10 ft copper clad steel constructed in accordance with UL 467. The copper thickness shall be 10 mil minimum, 15 mil average. Provide UL mark on ground rod.

2. Acceptable manufacturers:

a. Eritech (Erico)

b. Harger

c. Approved equal

C. Conduit grounding bushings

1. Insulated, rated for 150° Celsius, malleable iron type with a solderless set-screw lug.

2. Acceptable manufacturers:

a. Appleton

b. Hubbell Electrical Products (Raco)

c. Approved equal

D. Waterpipe ground clamps

1. Electroplated tinned bronze U-bolt style pipe clamp, sized as required for the pipe diameter and ground wire size specified.

2. Acceptable manufacturers:

a. Harger

b. Blackburn (Thomas & Betts)

c. Approved equal

E. VFD-Driven motor ground straps

1. Flat-braided tinned-copper strap, with circular hole on one end sized as required for the motor frame foot mounting screw, and ring terminal on the other end. Length shall be as required.

2. Acceptable manufacturers:

a. AEGIS

b. Panduit

c. Approved equal

F. Grounding system connections

1. Buried, encased, or in areas where connections will be not be readily accessible after completion of construction.

a. Buried, encased, or otherwise inaccessible grounding connections shall be made with exothermic welds. Molds, cartridge materials, and accessories shall be as specifically recommended by the manufacturer of the molds for the types of items to be welded. Molds and powder shall be furnished by the same manufacturer.

b. Acceptable manufacturers:

1) Erico (Cadweld)

2) Harger (Ultraweld)

3) Approved equal

2. Accessible connections to equipment, connections to exposed structural steel (e.g. steel columns), connections to reinforcing steel, connections made to ground rods located in ground rod boxes, and all other locations where the connections are readily accessible to maintenance personnel after completion of construction.

a. Mechanical connections to equipment, structural steel, and other accessible connections shall be made using one or two holes compression copper lugs as required for the cable size specified.

b. Mechanical connections to reinforcing steel shall be made using UL 467 listed irreversible crimp compression copper connectors with the “run” and “tap” sizes as required for the reinforcing steel and cable size, respectively, specified. Connectors shall be factory prefilled with moisture inhibiting compound.

c. Specific type of connectors shall be selected to match the specific connection to be made.

d. Acceptable manufacturers:

1) Harger

2) Blackburn (Thomas & Betts)

3) Burndy

4) Approved equal

G. Pre-cast concrete boxes for ground-rod installation

1. Provide where shown on the Drawings. Provide boxes with cast iron riser rings, and traffic covers inscribed “GROUND ROD”. Provide H-20 traffic rated boxes and covers.

2. Acceptable manufacturers:

a. Christy

b. Jensen Concrete Products

c. Approved equal

H. Electrical joint inhibitor compound

1. Use at all bolted grounding connections as a moisture and oxidizing seal.

2. Acceptable manufacturers:

a. Sanchem Inc., NO-OX-ID (A-Special Electrical Grade)

b. Approved equal

I. Manufactured Grounding Bus Bar: Grounding bus bar shall be a high conductivity copper alloy measuring 1/4-inch by 4-inches, minimum length of 12-inches or as shown on the Drawings. Bus shall be predrilled on 1-inch centers to accept grounding compression terminals bolted with brass bolts, nuts, and washers coordinated with the installation. Provide grounding bus bars by Burndy Type BBB; Chatsworth, or equal.

PART 3 EXECUTION

3.1 PREPARATION

A. Prepare and clean piping, rods, and conductors prior to exothermic welding in conformance with the specific requirements of the welding system.

B. Do not allow water pipe connections to be painted. If the connections are painted, disassemble them and remake them with new fittings.

3.2 INSTALLATION

A. General

1. Bond all exposed steel building columns in new structures together and connect to the grounding electrode system as shown on the Drawings. Connections to exposed structural steel columns or other exposed structural element shall be made with mechanical connectors.

2. Grounding of the pipe systems shall be provided per the requirements of NEC and as shown on the Drawings.

3. Metal conduits stubbed into power distribution equipment, control panels, or other enclosure shall be terminated with insulated grounding bushings and mechanically bonded to the enclosure's ground bus. Size the bonding wire in accordance with the NEC, except that a minimum No. 12 AWG shall be used.

4. Each separate building or structure shall have a grounding electrode or grounding electrode system per the requirements of the NEC.

5. All equipment enclosures, motor and transformer frames, conduits systems, cable armor, exposed structural steel and all other equipment and materials required by the NEC to be grounded, shall be grounded and mechanically bonded in accordance with the NEC.

6. Care shall be taken to ensure good ground continuity, in particular between the conduit system and equipment frames and enclosures. Where necessary, jumper wires shall be installed.

7. Liquid tight flexible metal conduit shall have bonding jumpers. Bonding jumpers shall be external, run parallel (not spiraled) and fastened with plastic tie wraps.

8. Run grounding electrode conductors in the building concrete slab/wall or as slab/wall-embedded unless otherwise shown on the Drawings.

9. Ground cable penetrations through building exterior walls shall enter within 3 feet below finish grade and shall be prepared with a water stop. Unless otherwise indicated, the water stop shall include filling the space between stands with solder and soldering a 12-inch copper disc over the cable.

10. Install equipment grounding conductors with all feeders and branch circuits. Each circuit shall have a dedicated equipment grounding conductor from source to load without splicing or "tee tapping" (e.g., three different receptacle circuits in a common home-run conduit back to a lighting panelboard shall have three separate equipment grounding conductors back to the lighting panelboard).

11. Ground metallic poles supporting outdoor lighting fixtures to a supplemental grounding electrode (rod) in addition to the separate equipment grounding conductor run with the supply branch circuit.

12. Use braided-type bonding jumpers to electrically bypass water meters. Connect to pipe with ground clamp connectors.

13. Mechanically bond interior metal piping systems and metal air ducts to equipment grounding conductors of associated pumps, fans, blowers, electric heaters and HVAC equipment. Use braided-type bonding straps.

14. Install driven ground rods in manholes and handholes close to wall and set rod depth at 4 to 6-inches above finished floor. Protect ground rods with double wrapping of pressure-sensitive tape or heat shrunk insulating sleeve from 2-in above to 6-in below concrete floor with connections of grounding conductors fully visible and accessible. Seal floor opening with waterproof, non-shrink grout. Where ground rods are installed outside of manhole or handhole, provide a No. 4/0 AWG bare copper conductor from ground rod into manhole or handhole through a waterproof sleeve in the wall. The ground rod shall be connected to the duct bank grounding electrode conductor where available.

15. Duct banks shall include a grounding electrode conductor. Duct bank grounding electrode conductors shall connect to the facility grounding electrode system, including the grounding system of all manholes and handholes.

16. Direct-burial grounding grid electrode conductors shall be installed at a minimum depth of 24 inches below subgrade unless otherwise shown on the Drawings. Care shall be exercised at cable crossings to avoid damage to the cable. Damaged cable shall be replaced with new cable.

B. Ground connections

1. Electric Motors and Electrical Equipment

a. Grounding conductors for motors and equipment shall be connected by a solderless terminal and a 5/16-inch, minimum, bolt tapped to the motor frame or equipment housing.

b. Large motors (over 100 HP) and major equipment items shall have at least 2 ground-pad-type connections and shall be attached to the main ground-grid at a minimum of 2 locations. Unless otherwise specified, connections of conductors to the equipment shall be with NEMA type, 2-hole, bolt-on bar lugs, and connections shall be made in accordance with the manufacturer's printed recommendations.

c. Paint, dirt, or other surface coverings shall be completely removed at the connection points of grounding conductors so that good metal-to-metal contact is made.

d. After grounding connections are made, areas around the connection point shall be prepared and the coating system repaired in accordance with Section 09900. Surfaces shall be restored to their original condition before the grounding connections are made.

e. Ground connections to smaller motors or equipment may be made by fastening the terminal to a connection box.

f. Junction boxes shall be connected to the equipment grounding system with 0.375-inch silicon-bronze machine screws.

2. VFD-driven motors

   a. Grounding straps for motors shall be connected by a circular punched hole on one end for installation around foot mounting screw of NEMA- or IEC-frame motor, and by a ring terminal on the other end secured to the metal ground by a bolt.

   b. Ensure metal-to-metal contact at both terminations by removing paint or corrosion at the motor foot and ground location.

3. Ground transformer neutrals, UPS neutrals, generators, and other separately derived sources to the nearest grounding electrode system as shown on the Drawings. The grounding electrode conductor shall be sized in accordance with the NEC unless otherwise specified on the Drawings. The grounding conductor shall be running continuous to the neutral (X/O) connection or run via an intermediate exposed bus bar located as shown on the Drawing or field located with the approval of the Engineer.

4. Shielded power cables shall be grounded at each termination point as required by the equipment and cable manufacturers or shown on the Drawings.

5. Ground instrumentation cable shields at a single point inside of the control panel at the signal grounding bus bar, unless grounding at the device is specifically required by the instrument manufacturer. Grounding of instrumentation shields shall conform to the requirements of Section 13400.

6. Ground data highway and network cables as required by the manufacturer of the communication equipment and per the requirements of Section 13400.

7. Grounding electrode conductors shall be exothermically welded to the foundation reinforcing steel grid as shown on the Drawings.

8. Seal exposed connections between different metals with electrical joint inhibitor compound. All buried connections shall be cleaned and coated with electrical joint inhibitor compound before backfilling.

9. Bolted connections shall not be buried or embedded. For compression-type connectors, the tool for crimping shall emboss the die index number into the connector as the crimp is completed. Each compression-type connector shall have an inspection port for use in checking proper conductor insertion. Compression connections shall be installed in strict accordance with manufacturer's printed recommendations using tools and dies of the proper size and type for the conductors, lug, and grounding electrode.

10. Molds used for exothermic welding shall be new. The number of welds made per mold shall not exceed the manufacturer’s published recommendations.

11. Where pipe flange or piping is grounded by means of a clamp or lug, the pipeline coating shall be repaired, except the grounding connection area, as shown on the project Drawings or as specified under Section 09900 herein.

12. Intersections: Intersections of grounding cables shall be bonded together.

13. Grounding taps and ground rods shall be connected by separate bonds to the main ground mat.

C. Ground rods

1. Install grounding electrodes at locations shown on the Drawings.

2. Drive ground rods to the depth shown on the Drawings. Interconnect ground rods and other grounding system components with the grounding conductor size shown on the Drawings.

3. Where solid or stratified rock is encountered perform the following

a. The Contractor shall auger a hole 10.5-feet deep, unless otherwise shown, and at least 4 inches in diameter.

b. Ground rods shall be placed and supported centrally in the hole.

c. Water shall be poured to fill the hole to 1/3 depth.

d. A granular grade of Bentonite (or approved equal) shall be gradually poured into the hole.

e. Pouring of water and Bentonite material shall be alternated until the hole is filled.

f. Throughout pouring, the material shall be thoroughly mixed to eliminate voids and ensure proper compaction.

g. Premixing water and Bentonite material in a separate container for placement into the hole shall not be permitted.

D. Grounding Conductors

1. Unless otherwise specified, provide continuous, unspliced equipment grounding conductors.

2. Lay all underground grounding conductors slack within 10 feet from the footing and, where exposed to mechanical injury, protect by PVC schedule 40 conduit or other approved physical protection. If guards are steel pipe, or other magnetic material, electrically connect conductors to both ends of the guard. Make connections as specified in this Section.

3. Where grounding conductors extend beyond the perimeter of the building to site structures, the grounding electrode system shall be continuous and the grounding conductor shall be encased in concrete ductbanks. Provide a minimum 2 layers of Aqua Seal over the taped assembly.

4. Conductors to equipment enclosures/tanks shall be neatly run along the face of concrete footings or structural steel, following surfaces closely to the point of connection. Conductors shall be supported and secured with cable fasteners at intervals no greater than 5 feet.

5. Conductors shall be mechanically bonded to metallic enclosures at each end and to intermediate metallic enclosures such as pullboxes.

6. Grounding conductors shall be connected to grounding bushings on raceways.

7. Where equipment contains a ground bus, grounding conductors shall be extended and connected to that bus. The enclosure of the equipment containing the bus shall also be connected to the bus.

8. Expansion Fittings: To relieve shearing and pulling action at structural expansion joints, cables shall be run in expansion joint fittings as shown on the Drawings.

E. Fasteners

1. Clean the connector and conductor surfaces with a wire brush or emery cloth to a shiny, bright surface. For plated surfaces, compatible solvent cleaning shall be used in order not to remove any portion of the plating.

2. Immediately after cleaning, apply an oxide-inhibiting compound with suspended copper particles on the threads of the connectors, ground plate, bolts, and other hardware used for making mechanical grounded connections.

3. All fasteners shall engage a minimum of four full threads for electrical connections and equipment mounting.

4. All bolts shall be coated with electrical joint inhibitor compound.

5. Torque fasteners to manufacturer's requirements and NETA specifications.

F. In addition to those items specified to be grounded above, the following metallic items shall also be grounded:

1. Cable tray sections, fittings, and connected raceways shall be effectively bonded and grounded.

2. Hatch frames.

3. Manhole and handhole cover frames.

4. HVAC equipment and duct work installed under Division 15.

5. Stairs and ladders.

6. Door frames for person access doors and rollup doors.

7. Building sheathing and exposed vertical structural elements.

8. Fences enclosing electrical equipment.

9. Non-electrical metallic items in close proximity with the exposed electrical equipment shall be grounded.

10. Equipment platforms that support electrical equipment. The support shall be bonded to the electrical equipment and the ground grid.

11. Frames and railings supporting push-button stations, receptacles, instrument cabinets, and raceways carrying circuits to these devices.

12. Handrails and guardrails: Handrails and guardrails shall be made electrically continuous with bond jumpers or welds at slip joints, as necessary.

3.3 INSPECTION AND TESTING

A. Inspect the grounding and bonding system conductors and connections for tightness, proper installation, and proper application of electrical joint inhibitor compound.

B. Testing shall be performed before energizing the distribution system. Refer to Section 16080.

C. A separate grounding system test shall be conducted for each building or system.

D. Notify the Engineer immediately if the resistance to ground for any building or system is greater than five ohms or if the resistance to ground for a substation is greater than one ohm.

E. Refer to Section 16080 for additional test requirements.

END OF SECTION

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SECTION 16075 – ELECTRICAL IDENTIFICATION

PART 1 GENERAL

1.1 SUMMARY

A. Section Includes

1. Requirements for identification of electrical, safety, measurement, monitoring, control, and related equipment

1.2 SUBMITTALS

A. Product Data – Submit per Section 01340 and Section 16000

B. Submit data base or spreadsheet identifying all identification nameplates, labels, and tags as specified.

C. Submit sample of each type and size of nameplate, label, tag, and means of attachment.

PART 2 PRODUCTS

2.1 MATERIALS

A. Standard enclosure and electrical panel nameplates/labels shall have black background with white engraved letters suitable for use from 40°F to 150°F, and shall be self-extinguishing and resistant to oil, water, and solvents. Emergency function nameplates/labels will use red background with white engraved letters. Nameplates/labels shall attach utilizing an adhesive backing that is appropriate for the surface of the equipment mounting base, surface of the equipment itself, or, if required, a separate but adjacent mounting point. The adhesive backing shall be appropriate for environmental conditions. Rivets or screws shall not be used.

B. Sizes shall be:

1. 2-inch-high nameplate/label with 1-inch letters.

2. 1-inch-high nameplate/label with ½-inch letters.

3. ¾-inch-high nameplate/label with ¼-inch letters.

C. Provide process equipment, instrumentation, valves, and other field equipment identification tags as follows:

1. Stainless steel.

2. 2-inch-round; .025–.050 inches thick.

3. Text shall be center justified.

4. Numbers, letters, and characters shall be 0.25-inch size.

5. Numbers, letters, and characters shall be black filled.

D. Conduit tag system shall comply with the following:

1. Provide permanent, stamped brass round tags conduit numbers as designated on the conduit schedule, pressure stamped onto the tag. Stamped conduit identification numbers shall have a minimum height of ¼-inches. Tags shall be fabricated from minimum 19 gauge brass with minimum diameter of 1-1/2-inches and predrilled mounting top hole.

2. Tags relying on adhesives or taped-on markers are not acceptable. Attach tags to conduits with 316 stainless steel clamps at each end and at least once in every 50 feet near the midpoint of exposed conduit in ceiling spaces, surface mounted, and inside manholes and handholes.

3. Conduits installed higher than 15 feet above finished grade or finished floor elevations shall be provided with large plastic identification nameplates at these locations.

4. Conduits shall be identified with one line of text that matches that used in the conduit schedule. Minimum character size shall be 1/2" black engraved lettering on white plastic nameplate.

5. Acceptable products

   a. Seton Identification Products

   b. National Band and Tag Company

   c. Emedco

   d. Approved equal.

E. Heat shrink tube marking system shall comply with the following:

1. Tubing shall be extruded type without a seam running the length of the tubing.

2. Tubing shall be white with minimum of # 10 font black text.

3. The labels shall be properly sized for the conductor or cable.

4. Hand marked labels shall not be allowed.

F. Terminal Block Color marking system for Division 16 equipment shall comply with the following:

1. Green/Yellow – Ground.

2. Black – Fused terminal blocks. Each terminal strip shall identify the voltage applied.

3. Blue – Direct Current (DC).

4. Gray – Alternating Current (AC) hot power (normally energized).

5. Gray with Orange switch button – Analog terminals with built-in isolation switch.

6. White – AC neutral.

G. Tape labeling system where specified shall comply with the following:

1. White 0.375-inch tape with # 14 black font characters

2. Clear 0.375-inch tape with # 14 black font characters

H. Vault identification system shall comply with the following:

1. Provide self adhesive yellow reflective characters measuring 1.75 inches wide by 3 inches tall, installed on a 4 inch by 12 inch smooth aluminum plate attached to the center top of the hatch cover with .25 inch diameter stainless steel bolts.

PART 3 EXECUTION

3.1 INSTALLATION

A. Conduit Identification

1. Conduits shall be identified with stainless steel marker plates attached with stainless steel ties near it's points of termination. The identification marker plates shall be attached in a manner that ensures it is readable.

2. Conduits installed flush with interior vault walls shall be identified with the phenolic tags specified and attached to the vault wall directly above the conduit with epoxy gel.

3. The identification shall be as the indicated on the conduit schedules located in the drawings. Conduits not indicated on the conduit schedules shall be added to the as-built conduit schedules and plan drawings and labeled accordingly.

B. Vault Identification:

1. Install vault identification nameplates on clean dry plates and attached to the center top of the box lid with .25 inch diameter stainless steel bolts.

C. Nameplate, Label, and Tag Identification

1. Nameplates and labels shall generally be used to give the layman or common identification name of the equipment and shall be a phenolic type.

2. Tags shall generally be used to give the technical or professional identification name and shall be a round stainless steel type.

3. Nameplates/labels shall attach utilizing an adhesive backing that is appropriate for the surface of the equipment mounting base, surface of the equipment itself, or, if required, a separate but adjacent mounting point. The adhesive backing shall be appropriate for environmental conditions. Rivets or screws shall not be used.

4. Identification tags shall be attached to equipment, valves, or pipes utilizing a stainless steel beaded chain. The chain shall provide two to three inches of slack when the tag is attached to the item.

5. Nameplates, labels, and tags shall be located on or next to equipment (and valves if required) in a manner that ensures that the nameplate/label is readable from the access point without interfering with the operation of the equipment or valve or any other equipment. Whenever possible nameplate/label shall be attached to a non-removable part of the equipment or valve.

6. General equipment, electrical equipment, boxes, enclosures, valves, instruments, etc. shall be identified as indicated on the Drawings for equipment requiring identification. The nameplates shall be the largest of the three sizes specified that will reasonably fit on the product being identified. Nameplates shall be mounted at the top and centered on the equipment when possible.

7. Equipment, valves, instruments, etc. shall be identified with a tag made of round stainless steel tag. Identification tags shall be attached to equipment, valves, or pipes utilizing a stainless steel beaded chain. The chain shall provide two to three inches of slack when the tag is attached to the item. Identification tags shall be attached to equipment, valves, or pipes in a manner that ensures that the tag is readable from the access point without interfering with the operation of the equipment, valve, pipe, or any other equipment. Whenever possible identification tags shall be attached to a non-removable part of the equipment or valve. The identification shall be as indicated on the Drawings.

8. Operator switches and panel mounted instruments, operator interfaces, etc. identification shall utilize ¾-inch-high phenolic nameplate for laymen process function description and use manufacturer provided legend plates for the standard hand, off, auto, start, stop, etc. description.

9. Control panels shall have a one-inch-high nameplate consisting of two lines of text. Line 1 shall be the panel equipment identification as indicated on the drawings and line 2 shall be text describing the process that is being controlled by the unit. A typical Control panel identification label would be:

PNL005D **Boiler # 1 Control**

10. The equipment identification label for the MCC shall be two-inch-high nameplate. The label shall be located at the top of the main feeder section on the face of the MCC. The label shall be one line of text as indicated on the Drawings.

11. Individual MCC bucket sections shall have a nameplate mounted in the lower left-hand corner of the bucket door labeled as a “Unit” with numbered columns and lettered rows as illustrated below. The bucket identification label for the MCC unit shall be a one-inch-high nameplate consisting of two lines of text. Line 1 shall be the equipment identification and line 2 shall be text describing the process that is being controlled by the MCC unit.

12. Switchgear shall have nameplates installed for the main equipment and bucket sections in the same manner and size as the MCC.

D. Conductor and Cable Identification

1. Conductors and cables shall be identified with white heat shrink tube marking system.

2. Single Shielded Twisted Pair (SSTP) Analog Cable Identification

   a. SSTP cables shall be identified using the three character loop number as indicated on the Drawings. SSTP cables in the same loop will have the same three character loop number.

   b. A numeric sequence designator shall follow the three character loop number. Each SSTP cable in the same loop will have different sequence designators.

   c. A dash (-) shall separate the three character loop number and the sequence designator.

   d. A typical SSTP cable identification name would be “186-1.” A second SSTP cable in the same loop would be “186-2.”

   e. The sequencing (186-1, 186-2, etc.) of analog cables (4-20 mA) will start with the source or a point of origination (typically the transmitter).

   f. Individual conductors within the cable shall be identified at each termination point. An example of this would be “TB1– 4.” This is terminal strip 1, terminal 4.

   g. The shield (drain wire) shall be identified at each termination point. An example of this would be “TB1– 6.” This is terminal strip 1, terminal 6.

   h. SSTP cable jackets shall be labeled at each termination point.

   i. Individual conductors within the SSTP cable shall be labeled at each termination point.

3. Multi-Pair Analog Cable Identification

   a. Multi-pair analog cables shall be identified by the enclosure equipment identification names of the enclosures that the cable is terminated at:

   b. Multi-pair analog cables shall include the prefix “MPC.”

   c. The “MPC” prefix shall be followed by the two termination enclosures equipment identification names.

   d. A dash (-) shall separate the enclosure equipment identification names.

   e. The “PNL” prefix of the enclosure equipment identification names shall not be included. For example if “PNL077A” is the first enclosure only “077A” will be included in the identification name of the cable. If “PNL053A” is the second enclosure only “053A” will be included in the identification name of the cable.

   f. A numeric sequence designator shall follow the source enclosures equipment identification names. Each multi-pair analog cable that terminates between the same two enclosures shall have a different sequence designator.

g. A typical multi-pair analog cable identification name would be “MPC077A-053A1” a second multi-pair analog cable that terminated in the same enclosures would be “MPC077A-053A2.”

h. Individual conductors within the cable shall be identified using the point of termination. An example of this would be “TB1– 4.” This is terminal strip 1, terminal 4.

i. Multi-pair analog cable jackets shall be labeled at each termination point.

j. Individual conductors within the multi-pair analog cable shall be labeled at each termination point.

4. Conductors Derived From Power Panels.

a. Ungrounded, grounded, and grounding conductors shall be identified by the panel and circuit number where they originate.

5. Monitoring and Control Conductor Identification.

a. Conductors not specifically identified elsewhere in this Section such as motor schematics and control panel wiring, shall be identified as indicated on the drawings.

6. Telephone, Data, Radio Cable Identification.

a. Cables shall be identified by the device they are feeding.

7. Network and Communication Cable Identification.

a. Cables shall be identified as indicated on the Drawing at all points of termination and pass-through points such as pull boxes. At pass-through points the identification tube shall be held in place with nylon tie wraps. Should a cable not be identified on the drawings, the City will provide the identification necessary.

8. Tape Labeling Identification Requirements

a. Terminal strips used for Division 16 panels or where specified shall be identified within each enclosure in the following manner. Terminal strips shall be numbered as TB1, TB2, etc. with each contiguous terminal strip in the panel numbered in sequence. Terminal strips can be mounted vertical or horizontal with the first strip, TB1, located as the upper most left terminal. Each succeeding contiguous terminal strip shall be numbered, TB2, TB3, etc. running top to bottom if mounted horizontal, or left to right if mounted vertical. Each terminal shall be numbered in sequence for each strip with the sequence beginning from number one on each strip. No individual terminals in a contiguous terminal strip will be numbered with identical numbers.

b. Labels shall be installed to identify all components within control enclosures of every type. Labels shall not be placed directly on devices or wireway covers. Labels shall be placed on backpanels for relays, fused, terminal strips, etc. and the back side of the enclosure doors for pushbutton switches, selector switches, operator interface terminals, etc. and shall be attached in areas free of wiring to ensure clear visibility without moving wires

or other devices. Labels shall be identical with component designation as shown on the Drawings of the system (i.e. 1CR, 2SS, 5LT, 3FU, etc.).

c. Provide tape style labels for device cover plates. Cover plates for data, phone, and speakers shall be as shown on Drawings. Cover plates for receptacles and switches shall be identified by the panel and circuit number supplying power to the device. Example: LP5A-15.

d. Provide tape style for light fixtures. The label shall indicate the power supply for the fixture. The tag shall be located inside the fixture adjacent to the ballast or electrical connection. Example: LP5A-15.

END OF SECTION

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SECTION 16080 – ELECTRICAL SYSTEM ANALYSES AND COMMISSION FIELD TESTING

PART 1 GENERAL

1.1 SCOPE OF WORK

A. Test systems and equipment furnished under Division 16 and repair or replace all work or equipment provided under this Contract found compromised or defective. Refer to the individual equipment Sections for additional specific testing requirements.

B. Employ the services of an independent recognized power systems testing company, other than the manufacturer of the switchgear or motor control centers, to perform the tests specified in this Section.

C. Field testing and commissioning shall be performed in accordance with the latest revisions of NETA Standard ATS "Acceptance Testing Specifications for Electrical Power Distribution Equipment and Systems" unless otherwise modified by these Sections. It is the intent of the specified tests to assure that all electrical equipment is operational and within industry and manufacturer's tolerances and is installed in accordance with design specifications. Tests and studies shall help determine suitability for energization.

D. Perform the following studies, tests, and settings for the entire facility including all existing major electrical distribution and motor control equipment and components and all new major electrical equipment provided under this Contract. Review adequacy of existing equipment ratings, coordination schemes, arc flash considerations incorporating specified arc flash mitigation methods, labeling strategies, and other work as specified.

E. Studies shall include analyses under utility, both generator supplies, and for both temporary/interim connections in place during construction and final connections at completion of construction.

F. Studies to be performed shall include:

1. Short-circuit

2. Coordination Studies.

3. Arc Flash Hazard Studies

4. Harmonic Analyses

5. Inspections and field testing.

G. Provide all material, equipment, labor, and technical supervision to perform electrical studies and acceptance testing.

H. Adjust all protective devices to the settings recommended in the short circuit, coordination study, arc flash study, and other analyses. Provide recommended settings and coordinate implementation for the differential and zone selective interlocking protection schemes specified under Section 16350 and Section 16436.

I. Coordinate harmonic mitigation protective devices with suppliers of VFDs and other harmonic generating equipment.

J. Coordinate electrical testing and commissioning with the phased sequence of construction per requirements of Section 01010.

K. The term “major electrical equipment” when used in this Section shall include all equipment operating above 480V and other equipment specified in this Section, including but not limited to:

1. Main 21kV Switchgear: MVSG 1

2. New 21kV – 480V transformers: XFMR “N” and XFMR “S”

3. New 480V Switchgear

4. Existing and modified 480V Switchgear

5. New 480V Switchboards

6. Existing and modified 480V Switchboards

7. New Motor Control Centers

8. Existing and modified 480V motor control centers

9. New and existing motors and drives.

10. Existing standby generator including associated circuit breakers, relaying, and other protective devices.

11. New standby generator including associated circuit breakers, relaying, and other protective devices.

12. Distribution dry-type transformers and lighting panels

13. Other equipment as necessary to comply with the coordination and arc flash requirements as specified in these Specifications and as per applicable standards and industry recommended practices.

L. Additional electrical distribution equipment testing is specified under the technical equipment specification Sections of Division 16.

M. Testing and startup of equipment conforming to PG&E standards. Note that repeat testing of medium voltage switchgear, relaying, battery systems, and other components will be required to be witnessed by PG&E engineers. Such testing shall be performed per PG&E interconnection standards. Refer also to Section 16001 and 16350

1.2 RELATED SECTIONS

A. All Division 16 Sections.

1.3 SUBMITTALS

A. All submittals shall be in accordance with the Section 01340 and Section 16000.

B. Submit Electrical Equipment Analysis and Testing Plan a minimum of four (4) after award of contract. Submittal shall include the following at a minimum:

1. Submit qualifications of firm or individual(s) proposed to perform the analytical studies confirming that the specified qualifications are met including professional engineering registration and experience requirements.

2. Submit qualifications of the firm performing the independent system commission and field testing confirming that the specified qualifications are met including NETA certification at the specified levels.

3. Proposed equipment and/or bus naming conventions to be used for the electrical analyses prior to preparation of the computer model. Bus naming shall reference and/or incorporate electrical equipment naming conventions shown on the Drawings as approved by the City.

4. Schedule of Electrical Analytical Studies and Commission Field Testing prepared using Microsoft Project, including:

   a. Dates of major electrical equipment shop drawing and product submittals

   b. Dates of electrical data acquisition and data requests to the City

   c. Dates of electrical model development

   d. Dates of submittal and Engineer review of all electrical analytical study reports

   e. Dates of re-submittal and Engineer review of all electrical analytical study reports

   f. Projected delivery and installation dates of major electrical equipment to the site

   g. Testing dates for each piece of major electrical equipment and for each type of test specified

   h. Startup and commissioning date for each major piece of electrical equipment

5. Representative samples of analytical reports for short circuit studies, coordination studies, arc flash studies, and harmonic studies indicating conformance with the specified study requirements.

6. Commission and field testing procedure narratives describing the sequence, type, and method of all tests.

7. Proposed testing forms and signoff sheets to be used for all electrical equipment where testing is required.

C. Submit electrical study reports including results for short circuit and coordination, arc flash, and harmonic analyses a minimum of twelve (12) weeks prior to scheduling any field testing.

D. Submit commission and field test reports for each testing cycle containing each component tested. Reports shall include

1. Cover sheet with the name of the testing firm and technician names performing the tests. Dates of the testing shall be included.

2. Table of Contents organized by equipment type and tag name.

3. Summary page explaining the purpose of the test, description of equipment, equipment identification tag matching the convention shown on the Drawings, technical specification reference of the equipment, and the specific testing requirement met by the test report. Individual equipment cross reference describing the equipment, location of the component and a report page sheet number on which the technical information is presented.

4. Test data sheets with each piece of equipment or component on a dedicated, unique sheet; page number; the name of the component under test, the major piece of equipment in which the component is located; weather conditions at the time of the test.

5. Opinion whether or not the equipment being tested complies with the specification. Any discrepancies shall be noted in the concluding summary of the report. Test report forms shall be in compliance with NETA standards. Three complete copies field testing, an officer of the firm performing the tests and an officer of the Electrical Subcontractor.

E. Electronic copies of reports and electronic copies of the final analytical databases in native format for the analytical package used for the analyses. Database shall be submitted on CD-ROM, thumb drive or other mass storage device.

F. Incorporate testing and electrical study results as part of the O&M Manuals per Special 01730 and as required per NFPA 70E for Arc Flash Labeling documentation.

1.4 REFERENCE STANDARDS

A. Testing and calculations required under this Section shall be per the guidelines specified in the NETA publication "Acceptance Testing Specification for Electric Power Distribution Equipment and Systems." Testing requirements in this Section are specifically referenced to the edition of this publication issues at time of bid opening.

B. All inspections and tests shall be in accordance with the following codes and standards except as provided otherwise in these Specifications. Where reference is made to one of the standards, the revision in effect at the time of bid opening shall apply.

1. National Electrical Manufacturer's Association – NEMA

2. American Society for Testing and Materials – ASTM

3. Institute of Electrical and Electronic Engineers – IEEE

   a. IEEE 141 – “Recommended Practice for Electrical Power Distribution for Industrial Plants”

   b. IEEE 242 – “Recommended Practice for Protection and Coordination of Industrial and Commercial Power Systems”

   c. IEEE 399 – “Recommended Practice for Industrial and Commercial Power System Analysis”

   d. IEEE 519 – “Recommended Practices and Requirements for Harmonic Control in Electrical Power Systems."

   e. IEEE/ANSI C57.109 – Guide for Liquid-Immersed Transformer Through Fault Current Duration

4. InterNational Electrical Testing Association

   a. NETA ATS – Acceptance Testing Specifications (latest edition)

5. American National Standards Institute

   a. ANSI C2 – National Electrical Safety Code

   b. ANSI C.37.010 – Standard Application Guide for AC High-Voltage Circuit Breaker

   c. ANSI C37.5 – Calculation for Fault Currents for Application of Power Circuit Breaker

   d. ANSI C37.13 – Low-Voltage AC Power Circuit Breaker (600-Volt Insulation Class)

6. National Fire Protection Association - NFPA

   a. ANSI/NFPA 70: National Electrical Code

   b. ANSI/NFPA 70B: Electrical Equipment Maintenance

   c. NFPA 70E: Electrical Safety in the Workplaces

   d. ANSI/NFPA 101: Life Safety Code

1.5 QUALIFICATIONS

A. Electrical Analysis Firm: The electrical analytical studies shall be performed by a registered professional electrical engineer in the state of California with a minimum of five years experience in the performance of such studies. Engineer shall have attended standard training sessions on the analytical package specified for use on this project.

B. Testing Firm Qualifications:

1. The Testing Firm shall have been continuously engaged in the testing of the type of electrical equipment furnished on this Project for a minimum of ten years.

2. The Testing Firm shall meet federal OSHA criteria for accreditation of testing laboratories, Title 29, Parts 1907, 1910, and 1936. Full membership in the International Electrical Testing Association constitutes proof of such criteria.

3. Testing Firm shall utilize only full-time technicians who are regularly employed and NETA certified. Technicians performing testing on this Project shall be supervised by a NETA ETT Senior Certified Level IV. Electrically unskilled employees are not permitted to perform testing or assistance of any kind. Electricians and/or linemen may assist, but may not perform testing and/or inspection services.

4. All instruments used by the Testing Firm to evaluate electrical performance shall meet NETA's Specifications for Test Instruments.

5. The testing firm shall have a designation of “NETA Accredited Company” issued by the InterNational Electrical Testing Association.

6. The testing firm shall submit appropriate documentation to demonstrate that it satisfactorily complies with these requirements.

1.6 ELECTRICAL SYSTEM ANALYSES WORKSHOP

A. The Contractor shall schedule and hold an electrical system analysis coordination meeting prior to performing any technical development or modeling. The meetings shall include as a minimum the Owner’s representative, the Contractor, the electrical subcontractor, and representative of the electrical system analyses firm. Meetings will be held at the WWTP site.

B. Prepare and distribute an agenda for the meeting a minimum of one week before the scheduled meeting date for review and comment by the Owner. Each meeting will last up to four (4) hours total length. Facilitate the meeting and submit draft meeting minutes for review by the Owner followed by final meeting minutes incorporating review comments and distribution to all attendees. Contractor shall be responsible for coordinating attendance of all non-City personnel including all Contractor staff and utility representatives.

C. System Analyses Workshop: The meeting shall be held no less than 30 calendar days following Notice To Proceed. The purpose of the meeting shall be to allow the Contractor to request specific data, data files, and information. The Contractor shall prepare a comprehensive plan for performing the analysis including acquisition of required data, coordination with equipment suppliers, demonstration of an understanding of the protection schemes shown on the Contract Documents, demonstration of an understanding of the utility interconnection requirements, and method for arc flash analysis and labeling. At the meeting the Contractor shall summarize understanding of the project describe proposed analytical techniques, present a preliminary schedule showing key project elements and milestone dates, and request any additional information required from the Owner.

PART 2 PRODUCTS (NOT USED)

PART 3 EXECUTION

3.1 ELECTRICAL ANALYTICAL STUDIES

A. General

1. All analyses in the study shall be performed using SKM Power*Tools © with required analytical add-on modules, no equal to match existing City studies.

2. The database for the study to be performed under this Contract shall match nomenclature and identification approaches used on the Drawings and as submitted by the Contractor.

3. The final electronic database and library for the approved final study shall be submitted to the Engineer on CD, thumb drive or other mass storage device in the native format of the analytical package used for the study. Construction Manager and Engineer will verify compatibility of CD submitted files with the SKM software provided under this Section.

B. The study shall be in full compliance with applicable ANSI and IEEE Standards.

C. The firm performing the study shall be responsible for obtaining all data required to complete the study and determine recommended setpoints. Data to be obtained shall include available utility short circuit, all new and existing equipment characteristics, feeder sizes and lengths, new and existing loads and motor characteristics, and all other input data necessary to complete the requirements of this Section.

D. Record drawings and other information of the existing electrical distribution system will be made available upon request from the City after Notice of Award. However, the accuracy of the existing documentation has not been confirmed. Contractor shall be responsible for field verification of all new and existing input data used for the study.

E. All studies shall be stamped and signed by a Professional Electrical Engineer currently registered in California.

3.2 SHORT CIRCUIT AND PROTECTIVE DEVICES COORDINATION STUDY

A. Provide a complete short circuit study and protective device coordination study for the power distribution system including both modified existing and new system elements. The study shall include the following major components:

1. New 21 kV distribution system, switchgear, protective devices, transformers, and other medium voltage equipment provided under this Contract including relay protection schemes for system coordination and safety, standby generator, and automatic source transfer controls

2. 21kV-480V transformers.

3. New and existing 480V switchgear. Study shall include analysis of all new and existing buses, loads, and protective devices including implementation of relay protection scheme for system coordination and safety.

4. New MCC, distribution switchboards, and motor controllers

5. All existing MCCs. MCCs modified under this Contract shall be analyze\d with the changes detailed in the Contract Documents. Obtain existing protective device settings in existing equipment to develop settings for system coordination and safety.

6. New and existing motors and drives; individual motors larger than 50hp; motors smaller than 50hp may be modeled as combined or composite loads as defined in ANSI C37.010 and C37.5.

7. Existing standby generator including associated circuit breakers, relaying, and other protective devices.

8. New standby generator including associated circuit breakers, relaying, and other protective devices.

9. Distribution dry-type transformers and lighting panels

10. Other equipment as necessary to comply with the coordination and arc flash requirements as specified in these Specifications.

B. The study shall include at a minimum:

1. Overall electrical distribution single line diagram, including utility, generators, transformers, cables, motor control centers, VFDs, and all other source and end use equipment included in the limits of the study. The diagram shall identify each bus, transformer, reactor, etc, by name and corresponding node number using the approved bus tagging scheme. The available fault currents, Thevenin impedance and X/R ratio for each node, shall be indicated on the diagram. The single line diagram shall include cable sizes, lengths, transformer voltage, and transformer kVA.

2. Available three phase and ground fault asymmetrical and symmetrical fault currents at each piece of electrical equipment, bus, transformer, etc.

3. Overall system impedance diagram. The diagram shall include the power companies impedance and X/R ratio, circuit element impedances (e.g. transformers, generators, motors, VFDs, feeders, distribution buses, etc.).

4. The available fault current at each bus within the limits of the study shall be identified and listed.

5. The momentary and interrupting rating of all elements of the distribution system shall be listed. The maximum available fault current available at each element shall be calculated.

6. Determine the adequacy of the electrical protective devices to withstand the maximum available fault at the terminals of the equipment. Provide an equipment list, the equipment rating (both momentary and withstand), the maximum available fault rating and the adequacy of the equipment to withstand the fault. Equipment that does not have adequate ratings shall be identified immediately and brought to the attention of the Engineer.

7. Provide a complete set of time-current coordination curves on log paper. Limit the number of protective devices shown on any drawing to a maximum of four. A single line diagram depicting the portion of the distribution system under study shall appear with the curve. The minimum size log paper to be submitted shall be 11.5-in by 18-in.

8. The time current curves shall include transformer ANSI damage and inrush curves, cable damage curves, motor damage curves, capacitor damage curves, generator damage curves, circuit breaker and fuse ratings and settings, protective relay settings and any other information required by ANSI and good design practices. As a minimum provide curves for:

    a. Utility protective device to service entrance main circuit breaker.

    b. Each low voltage feeder down to 480 volt main switchboard and variable frequency drives.

    c. Each main and worst case representative feeder circuit breaker(s) located in the 480 volt main switchboard.

    d. Each ground fault protective device provided for 480 volt distribution systems.

    e. Motor starting profile for the largest motor connected to the main switchboard.

    f. A tabulation of all the settings for every over current protective device, timer, power system relays (e.g. ANSI 25, 27, 32, etc), circuit breaker, recommended fuse and current transformer ratings, etc.

    g. Transformer damage curves in accordance with ANSI C57.109.

    h. Transformer excitation current

    i. Motor, generator and cable damage curves in accordance with the manufacturer's recommendations.

    j. Select relay types (i.e. inverse, very inverse, extremely inverse, over current with or without voltage restraint, timers, etc), current transformer ratings and types, fuse, residually or zero sequence connected ground faults protection, etc, that will allow the system to be protected to within the equipment fault ratings and provide the maximum possible coordination between the protective devices.

    k. A complete set of coordination curves for every protective relay, circuit breaker, fuse, timer, etc, serving or located in the electrical equipment furnished for the project including the utility protective devices.

9. Executive summary describing the distribution system, the procedures used to develop the study, utility related information furnished by the utility company including the name and telephone number of the individual supplying the information, identify all assumptions made in the preparation of the study, identified any problem areas and provide a definitive statement concerning the

adequacy of the distribution system to interrupt and withstand the maximum possible fault current.

10. Computer printout of the input data

11. Computer printouts for the three phase, single phase and ground fault studies. Printouts shall indicate the fault current available at each major equipment, distribution bus.

12. Table listing all the electrical distribution and utilization equipment, the equipment interrupting and withstand ratings, the available fault current at the terminals of the equipment and the ability of the equipment to interrupt and/or withstand the fault.

C. Provide a short circuit and system coordination report coordinated with the approved submitted equipment shop drawings. The report shall confirm equipment is being applied within design ratings and electrical protective devices will coordinate.

1. Provide recommended coordination settings for all protective devices.

2. Provide recommended settings for the arc flash sensor based protection scheme for the 21kV Switchgear as specified in Section 16350.

3. Provide recommended settings for the zone protective interlocking protection scheme for the 480V Switchgear as specified in Section 16436.

4. The coordination study shall be submitted as a bound or 3-hole punch binder in a standard 8-1/2-in by 11-in size format. The selection of all protective relays types, current transformers, fuse types, and ratings shall be the responsibility of the manufacturer and shall be based on the preliminary draft, of the coordination study.

5. The complete study shall be favorably reviewed by the Engineer before any equipment is shipped.

3.3 ARC FLASH HAZARD STUDY

A. Perform an arc flash hazard study after the short circuit and protective device coordination study has been completed. The arc flash hazard study shall include operation during normal conditions alternate operations, emergency power conditions, and any other operations, which could result in maximum arc flash hazard.

B. Perform the arc flash hazard analysis for all equipment (including 120V control panels) provided or modified under this Contract having a nominal operating voltage greater than 50 Volts AC to ground.

C. Pertinent data, rationale employed, and assumptions in developing the calculations shall be incorporated in the report.

D. The study shall be prepared in accordance with applicable NFPA 70E, OSHA 29-CFR, Part 1910 Sub part S and IEEE 1584 Standards.

E. The study shall include as a minimum the following:

1. Flash Hazard Protection Boundary
2. Limited Approach Boundary
3. Restricted Boundary
4. Prohibited Boundary
5. Incident Energy Level or required Personal Protective Equipment Class
6. Type of Fire Rated Clothing

F. Submit Arc Flash Warning labels listing items above for all equipment analyzed in the study. Labels shall include the bus name and voltage. Provide permanent thermal transfer type, factory manufactured labels in conformance with NFPA 70E and ANSI Z535. Labels shall be made of high adhesion polyester and have electronic generated characters with no field markings. Labels shall be printed in color.

G. Produce individual Bus Detail sheets for each location where an Arc Flash Warning label is provided. The sheets shall list the items from above and the following additional items:

1. Bus Name
2. Upstream Protective Device Name, Type, and Settings
3. Bus Line to Line Voltage

H. Produce Arc Flash Evaluation Summary Sheet listing the following additional items:

1. Bus Name
2. Upstream Protective Device Name, Type, and Settings
3. Bus Line to Line Voltage
4. Bus Bolted Fault
5. Protective Device Bolted Fault Current
6. Arcing Fault Current
7. Protective Device Trip / Delay Time
8. Breaker Opening Time
9. Solidly Grounded Column
10. Equipment Type
11. Gap

12. Arc Flash Boundary

13. Working Distance

14. Incident Energy

15. Required personal protective equipment (PPE) protective blast rated clothing energy rating or protection class

I. The complete study shall be submitted and approved by the Engineer at least 30 Days prior to energizing the electrical equipment.

3.4 HARMONIC ANALYSIS STUDY

A. System Harmonics:

1. System Study A: Perform a system-wide harmonic analysis incorporating all new and existing harmonic sources connected to SWGR-A.

2. System Study B: Perform a system-wide harmonic analysis incorporating all new harmonic sources connected to SWGR-D.

3. All harmonic analyses shall use the source switchgear, switchboard, or MCC bus providing 480V power to the modeled harmonic sources

B. Source Power:

1. Perform studies under both utility and standby generator power as specified under Section 16230.

2. Perform studies for SWGR-A under both utility and standby generator power from the existing standby generator. Existing standby generator study parameters shall be provided by the City after Notice to Proceed.

3. Perform studies for SWGR-D under both utility and standby generator power from the new standby generator. New standby generator study parameters shall be provided by the Contractor based on the submitted and approved standby generator provided under this Contract.

C. Perform studies with the harmonic mitigation devices shown on the Contract Documents. If additional harmonic mitigation equipment beyond that provided under this Contract immediately notify the City. If additional harmonic mitigation equipment beyond that provided under this Contract due to the Contractor's equipment selection process, provide such equipment including all interconnecting conduit, wire, mounting, CTs, PTs, etc. at no additional cost to the City.

D. Calculations shall use the value of available short circuit current obtained from the utility company, and equipment parameters for generator, transformer, protective devices, other equipment provided under this Contract. Prepare calculations using feeder sizes and lengths as shown on the Drawings.

E. Individual and total voltage and current distortion at the indicated point of common coupling shall meet requirements of IEEE 519 for General Systems

F. Submit harmonic report in an 8-1/2x11 inch binder, 3 hole punched. Oversized sheets such as system single line diagrams shall be limited to 11x17, z-folded into the binder as required to ensure legibility. Include match lines or other means to present the entire system single line diagram using the 11x17 sheets specified. Minimum font size shall be 6 point.

G. Analysis report shall include at a minimum:

1. Sections clearly and logically organized with a table of contents.

2. An executive summary section with assumptions and recommendations.

3. All input data and assumptions

4. Explanation of the study results with specific recommendations on filters or other measures required to meet the specified limits.

5. Individual equipment voltage and current harmonic content and distortion levels up to and including the 31st harmonic, at the combined total harmonic content as a percent of the 60HZ fundamental under the load conditions specified and point of common coupling indicated.

6. A system impedance diagram based on the electrical one-line diagrams included in the Drawings. Diagram shall clearly indicate impedance values used for the study and relate directly back to circuit and load identifications and callouts used on the Contract Documents.

7. Utility component representing available short circuit current and X/R ratio from the electric utility

8. Standby generator short circuit characteristics, subtransient reactance, X/R ratios provided by the equipment supplier per Section 16230

9. Point of common coupling

10. All non-linear loads shown individually for equipment greater than 10HP including variable frequency drives, UPS, and AC to DC conversion equipment. Harmonic source models developed for each nonlinear load type. The load characteristics/harmonic spectra shall be determined or approximated based on the ultimate equipment provided and used as harmonic sources for the computer simulations.

11. All linear loads in switchgear, switchboard, motor control centers, distribution panels/panelboards may be modeled as a lump sum

12. Bus tagging per the approved bus identification scheme

13. Incorporate VFD equipment characteristics per Section 16264 and 16442

14. In accordance with applicable sections of IEEE 519 Standard.

H. Should the results of the harmonic analysis reveal non-compliance with the specified IEEE-519 requirements, provide suitable harmonic mitigation equipment such as active filters, passive filters, regulators, or other equipment as required to achieve the specified conformance. Additional harmonic analyses shall be performed as required to demonstrate conformance with the required harmonic limits. Additional analyses and harmonic mitigation systems including hardware, installation, protective devices, conduit and wire shall all be provided at no additional cost to the City.

I. Report shall include:

1. Single line diagram showing total demand distortion for each impedance element and total harmonic distortion for each bus.

2. Computer printouts of the calculated harmonic currents and voltages at each impedance element and buses.

3. Computer printouts of calculated voltage waveforms, harmonic spectrum, and frequency response plots at the point of common coupling.

4. Copies of manufacturer data on harmonic spectrum produced by each non-linear load in the system.

5. Recommendations for mitigating the total harmonic voltage distortion or total current demand distortion on the system if the combination of loads exceeds or violates the specified limits.

6. Recommendations for mitigating the impact of the harmonic distortion on plant equipment or processes if the levels are such that equipment or processes may be impaired.

3.5 GENERAL COMMISSION FIELD TESTING PROCEDURES

A. The testing agency instruments shall be maintained in calibration per the requirements of NETA.

B. The test reports shall be in accordance with NETA except that reports shall be completed no later than 30 Days after completion of testing on each piece of equipment.

C. Safety procedures as documented in CAL OSHA, NETA, and other industry standards shall be adhered to.

3.6 FIELD TEST EQUIPMENT

A. All test equipment shall be in good mechanical and electrical condition.

B. Selection of metering equipment should be based on the waveform of the variable being measured. Digital multimeters shall be RMS sensing type unless another type is required to accurately measure the variable under test.

C. Field test metering used to check power system meter calibration must have accuracy higher than that of the instrument being checked.

D. Accuracy of metering in test equipment shall be appropriate for the test being performed.

E. Waveshape and frequency of test equipment output waveforms shall be appropriate for the test and tested equipment.

F. Test Instrument Standards

1. All equipment used for testing and calibration procedures shall exhibit the following characteristics:

a. Maintained in good visual and mechanical condition

b. Maintained in safe operating condition

c. Portable multimeters shall be true RMS measuring.

d. Test equipment should have operating accuracy equal to, or better than, the accuracy as recommended by NETA standards.

G. Test Instrument Calibration

1. The Testing Firm shall have a calibration program which assures that all applicable test instruments are maintained within rated accuracy.

2. The accuracy shall be directly traceable to the National Institute of Standards and Technology.

3. Instruments shall be calibrated in accordance with the following frequency schedule:

a. Field instruments: 6 months maximum.

b. Leased specialty equipment: 12 months (Where accuracy is guaranteed by lessor)

c. Dated calibration labels shall be visible on all test equipment.

d. Records, which show date and results of instruments calibrated or tested, must be kept up-to-date.

e. Up-to-date instrument calibration instructions and procedures shall be maintained for each test instrument.

f. Calibrating standard shall be of higher accuracy than that of the instrument tested.

3.7 COMMISSION AND FIELD TESTING APPROACH AND DOCUMENTATION

A. General Requirements

1. Testing and commissioning shall be performed in accordance with the latest revision of NETA Standard ATS "Acceptance Testing Specifications for Electrical Power Distribution Equipment and Systems.

2. Testing shall be performed in three separate and totally independent steps.

3. Test reports:

   a. A typed report shall be submitted after each testing step is completed. The report shall be submitted to the Engineer for review, comment and record purposes.

   b. The report shall include a separate data sheet for each component (i.e. cable, circuit breaker, transformer, relay, etc.) tested. Each data sheet shall include the weather conditions at the time of the test (i.e. temperature, humidity, sunny, rain, etc) the tester's observation and findings, discrepancies, any remedial work performed or act to resolve problems, technical parameters obtained during the tests, as left settings of all devices, and a statement indicating the equipment is ready to be energized.

   c. The report shall be organized in a three-ring binder and provided with an table of contents.

   d. The report shall contain a statement indicating the equipment was tested in accordance with the procedures outlined in the latest edition of The International Testing Association Acceptance Testing Specifications.

B. Test sequence summary: The following describes the testing steps to be performed:

1. Step No. 1 – Contractor’s Preliminary Test: Before the electrical equipment is energized the Contractor shall test the equipment and set all protective relays, timers, etc, in accordance with the approved Short Circuit and Coordination Study and Arc Flash Hazard Study.

2. Step No. 2 – Manufacturer’s Field Tests where required under the detailed technical specifications included in Division 16.

3. Step No. 3 – Commissioning testing

4. Step No. 4 – Utility Witness Testing

C. The Engineer shall be notified in writing immediately of any and all components that have unsatisfactory test results. The notification shall be accompanied with a proposed remedy, remedy schedule, and impact to the project schedule.

D. Step No. 1 – Contractor’s Preliminary Tests: Testing requirements to be performed by the Contractor before the equipment is energized:

1. Inspect and mechanically operate all air interrupter switches, circuit breakers, power disconnect switches, switches supplied on transformers, and circuit breakers/disconnect switches installed within equipment furnished under other divisions of these specifications.

2. Set, calibrate and test all protective devices including but not limited to, circuit breakers, protective relays, timing devices, motor overload, electrical protective devices located with equipment furnished under other Sections of these specifications.

3. Verify that protective relay, current transformers, ground sensing devices, transformer grounding resistors, fuses, interrupter switches, transfer switches, transformers and motor starters furnished are in accordance with the approved shop drawings and the Short Circuit and Coordination Study and Arc Flash Hazard Study.

4. Megger test all low voltage power system cables.

5. Test transformer insulating oil, check connections and proper torque and tightness of cables and bushings and perform high potential testing.

6. Verify that all power and control power fuses installed are in accordance with the manufacturer's approved shop drawings, the Protective Device Selective Coordination Study and the NEC. Replace fuses found to be of the incorrect rating.

7. Verify control circuits and functionality of the controls for all motors, automatic transfer systems, remote protective device (i.e. wiring for differential protection relays, alarms systems, safety interlocks, emergency stop controls, and motor, transformer and generator protective devices). The functionality shall be in accordance with the approved control schematics, wiring diagrams or functional descriptions.

8. Check motor nameplates for correct phase and voltage; verify motor phase rotation

9. Verify the resistance to ground of all power distribution equipment is 5 ohms or less.

10. Verify all terminations at the main switchboard, motors, and VFDs, are correctly made and properly torqued.

11. Refer to the individual equipment and material specification Sections for additional testing requirements.

12. Verify all circuit breaker ratings and settings are as required by the Contract Documents or as amended during shop drawing review. Advise the Engineer of discrepancies and make changes as directed by the Engineer.

13. Verify proper operation of accessories devices and motor interlocks.

14. Submit comprehensive test report.

E. Step No. 2 – Manufacturer's Field Tests: Where required under the detailed technical specifications included in Division 16.

F. Step No. 3 – Employ the service of a third party electrical power systems testing company (the Testing Firm) to perform a final acceptance test of the completed electrical systems. "Third Party" shall mean a testing firm that is not affiliated with the Contractor or Electrical Subcontractor.

1. The Testing Firm shall obtain the test reports for testing previously submitted along with the approved/corrected Short Circuit and Coordination Study and Arc Flash Hazard Study before starting the testing and shall become familiar with the approach, conclusions, and recommendations. All potential discrepancies shall be addressed before the testing begins.

2. Test all new and modified equipment, components, controls, systems, and hardware provided under this Contract.

3. Testing shall follow the specific NETA procedures, including "optional" items, for the equipment being tested.

a. Testing shall follow all NETA procedures for the particular equipment or systems being tested.

b. Standard NETA test forms or equivalent shall be utilized in conformance with the favorably reviewed test plan.

c. All visual and mechanical inspections and electrical tests shall be performed in accordance with the latest edition of the NETA requirements.

d. Perform inspections and testing for all the equipment in conformance with NETA guidelines including all inspections and testing requirements listed as "optional".

e. The NETA requirements for visual and mechanical inspections of equipment are considered the Contractor's responsibility under this Work. At the Contractor's discretion, however, the work may be included under this Section.

G. Step No. 4 - Perform additional witness testing of protective devices with utility representatives present per utility standards for confirmation of utility requirements prior to energization of new utility service. Utility witness testing shall be scheduled and coordinated by the Contractor with the utility and the construction schedule for the new service work. Testing shall follow procedures and guidelines for protective devices, relays, battery systems, and other equipment as documented in utility standard practices.

END OF SECTION

SECTION 16120 – LOW VOLTAGE CONDUCTORS AND CABLES

PART 1 GENERAL

1.1 DESCRIPTION

A. Furnish and install low voltage cable systems as specified herein, complete, and in operating condition.

B. Furnish and install 600Volt, 3 Phase, 4 Wire enclosed non-segregated bus assemblies (bus-duct) and fittings between the new 480 V main feeders and existing switchgear SWGR A as shown on the Drawings and as specified herein.

C. Conduit and Raceway Schedules indicating conductor number and minimum required conductor sizes are included in Section 16130.

D. The Schedules are prepared as a guide to the Contractor and additional circuits from home runs, specialty manufactured cables, and supplier specific wiring may require additional conductors not specifically included in the schedule. Such omissions in the Schedules shall not relieve the Contractor of the responsibility of furnishing and installing the necessary cables and raceways as required by the remainder of the Contract Documents for a fully functioning and operational system.

1.2 RELATED SECTIONS

A. Refer to Division 13 for additional system testing requirements and network and data highway cable requirements

B. Section 16000 – Common Work Results for Electrical.

C. Section 01612 – Seismic Design Criteria

D. Section 16080 – Electrical Systems Analyses and Acceptance Testing.

E. Section 16121 – Medium Voltage Conductors and Cables.

F. Section 16122 – Fiber Optic Cables

1.3 SUBMITTALS

A. Submittals shall be made in accordance with Section 01300 and Section 16000.

B. Submit catalog data indicating manufacturer, insulation designation, and ratings in sufficient detail to determine conformance with these specifications:

1. Power, control, and instrumentation wire.

2. Termination and splicing materials.

3. Pulling lubrication compound.

4. Circuit identification system.

C. Bus Duct

1. General: Indicate bus duct type, dimensions (plan and elevation), cross-sectional drawings (showing bus bar arrangement, supporting blocks and housing arrangement), bus termination drawings (details to connecting transformers and switchgear), support points and finishes.

2. Product Data: Provide data for bus duct type fittings, covers, wall penetrations and other accessories.

3. Test Report: Provide test reports showing compliance with the following ANSI-37.23 design tests; temperature rise, insulation withstand, impulse, wet and dry withstand, momentary short-circuit, insulation flame retardance and water tightness.

4. Manufacturer's Instructions: Indicate applications conditions and limitations of use stipulated by product testing agency specified under Regulatory Requirements. Include instructions for storage, handling, protection, examination, preparation, installation, and energizing of product.

5. Submit seismic calculations for mounting hardware for review per the requirements of Section s 01612. Calculations shall include analysis of bus duct routing and configuration as shown on the Drawings.

6. Submit wall penetration system complying with UL requirements for the applicable through-penetration firestop system.

7. Manufacturer’s instructions:

   a. Installation and operating instructions.

   b. Itemized list of spare parts furnished specifically for this project including quantity, price, description and part numbers.

D. Submit results of field testing for new conductors provided under this Contract and for existing conductors tested under this Contract as noted on the Drawings and as specified in Section 16080.

E. Submit, in accordance with Section 01300, samples of proposed wire. Each sample shall have the size, type of insulation and voltage stenciled on the jacket. Approved samples will be sent to the project location for comparison by the Resident Engineer with the wire actually installed.

1.4 REFERENCES

A. American National Standards Institute (ANSI)

1. ANSI 37.23 – Standard for Metal Enclosed Duct

B. American Society for Testing and Materials (ASTM):

1. B-3 – Standard Specification for Soft or Annealed Copper Wire.

2. B-8 – Standard Specification for Concentric-Lay-Stranded Copper Conductors, Hard, Medium-Hard, or Soft.

3. B-33 – Standard Specification for Tinned Soft or Annealed Copper Wire for Electrical Purposes.

C. International Cable Engineers Association (ICEA).

1. S-95-658 – Non-Shielded Power Cable Rated 2000V or less

2. S-61-402 – Thermoplastic Insulated Wire and Cable for Transmission and Distribution

D. National Fire Protection Association (NFPA):

1. NFPA 70 – National Electrical Code (NEC).

E. National Electrical Manufacturers Association (NEMA):

1. NEMA BU.1, Bus Ducts

2. NEMA WC 3, Rubber-Insulated Wire and Cable for the Transmission and Distribution of Electrical Energy

3. NEMA WC 5, Thermoplastic-Insulated Wire and Cable for the Transmission and Distribution of Electrical Energy

4. NEMA WC 7, Cross-Linked- Thermosetting- Polyethylene-Insulated Wire and Cable for the Transmission and Distribution of Electrical Energy

F. Telecommunications Industry Association (TIA)

1. EIA-568-B.2-1 – Commercial Building Telecommunications Cabling Standard Part 2: Balanced Twisted-Pair Cabling Components

G. Underwriters Laboratory (UL):

1. Standard 44 – Thermoset Insulated Wires and Cables

2. Standard 83 – Thermoplastic Insulated Wires and Cables

3. Standard 444 – Communications Cables

4. Standard 510 – Polyvinyl Chloride, Polyethylene, and Rubber Insulating Tape

5. UL 857 - UL Standard for Safety Bus ducts and Associated Fittings.

6. Standard 1277 – Standard for Electrical Power and Control Tray Cables with Optional Optical-Fiber Members

7. Standard 1569 – Standard for Metal-Clad Cables

8. Standard 1581 – Reference Standard for Electrical Wires, Cables and Flexible Cords.

9. Standard 1666 – Standard for Test for Flame Propagation Height of Electrical and Optical-Fiber Cables Installed Vertically in Shafts

10. Standard 1685 – Standard for Vertical-Tray Fire-Propagation and Smoke-Release Test for Electrical and Optical-Fiber Cables

1.5 CONDUCTOR COLOR CODING

A. Color coding of multiconductor control and instrumentation cable is specified in the individual cable type specification.

B. For power conductors, provide all single conductors and individual conductors of multiconductor power cables with integral insulation pigmentation of the designated colors, except conductors larger than No. 6 AWG may be provided with color coding by wrapping the conductor at each end and at all accessible locations with vinyl tape. Where this method of color coding is used, wrap at least six full overlapping turns of tape around the conductor covering an area 1 1/2 to 2 inches wide at a visible location at all conductor termination and pulling points.

C. Phase A, B, C implies the direction of positive phase rotation.

D. Mark conductors using the following colors for power conductors.

System	Conductor	Color
All Systems	Equipment Grounding	Green
120/240 Volts, 1-Phase, 3-Wire	Line 1 Line 2 Neutral	Black Red White
208Y/120 Volts, 3-Phase, 4-Wire	Phase A Phase B Phase C Grounded Neutral	Black Red Blue White
480Y/277 Volts, 3-Phase, 4-Wire	Phase A Phase B Phase C Grounded Neutral (if used)	Brown Orange Yellow White, Black Tracer

E. All conductors carrying AC foreign voltage over 100 Vac into control panels, switchboards, and other enclosures shall be yellow. Multi-conductor cables carrying such foreign voltage shall be marked with yellow tape at each termination point.

1.6 DELIVERY, STORAGE AND HANDLING

A. The Contractor shall inspect the reels as they are unloaded from the delivery truck, any visible damage shall be reported by the Contractor and the reel returned to the factory.

B. The Contractor shall provide a crane, special lift truck or forklift suitably rated to unload the cable reels.

C. Cables shall be packaged on spools or reels. Each package shall contain only one continuous length of cable. The packaging shall be constructed so as to prevent damage to the cable during shipping and handling.

PART 2 PRODUCTS

2.1 CONDUCTORS

A. General

1. All wire and cable conductors shall be annealed soft drawn copper with 98% conductivity. Aluminum conductors are not acceptable and shall not be used.

2. Provide Class B stranded conductors in all cases except that wiring for lighting and receptacle circuits may be solid.

3. Conductors shall be in accordance with applicable NEMA standards WC 3, NEMA WC 5, or NEMA WC 7. All conductors shall be UL Listed.

4. All conductors installed in tray shall be tray rated (Type TC) and run without splices in and out of the cable trays.

5. All conductors shall have ampacity ratings at 90° C in dry locations and 75° C in wet location minimum in accordance with the NEC unless noted otherwise.

6. Conductor sizes shown on the Drawings or schedules shall be the minimum size provided regardless of the type of conductor used.

7. Wire smaller than No. 12 AWG shall not be used for power feeders. Wire smaller than No. 12 AWG shall only be used for control, signal and instrumentation circuits,

B. 600 Volt Single Conductor Power and Building Wire

1. Wire for circuits over 150 Volts to ground shall be NEC type XHHW/XHHW-2 for sizes 4/0 AWG and smaller and shall be NEC type RHW for sizes 250 kcmil and larger as manufactured by the Okonite Co.; Carol Cable Co. Inc.; Pirelli Cable Corp. or approved equal.

2. Wire for lighting, receptacles and other circuits not exceeding 150 Volts to ground shall be NEC type THHN/THWN as manufactured by the Okonite Co.; Carol Cable Co. Inc.; Pirelli Cable Corp. or approved equal.

3. Where flexible cords and cables are specified, Type SO, 600-volt shall be provided, having the number and size of copper conductors shown on the drawings.

4. Acceptable Manufactures:

   a. Okonite, X-Olene

   b. Southwire

   c. General Cable

d. Approved equal

C. Single Conductor Control, Status, and Alarm Wire

1. Single conductor wiring shall be 600V, No.14 AWG NEC type XHHW/XHHW-2 and type MTW inside control panels as manufactured by the Okonite Co.; Carol Cable Co. Inc; Pirelli Cable Corp. or equal.

D. Variable Frequency Drive (VFD) Cable 600V and Less.

1. For installation in conduits between VFD and motor.

2. Three stranded XLPE insulated circuit conductors with full size insulated tinned copper ground conductor and full size stranded tinned copper drain wire.

3. Jacket shall be oil resistant and sunlight resistant PVC type.

4. 100% overall aluminum shield and 85% braid coverage.

5. Provide cable that is UL listed and tray rated conforming to the requirements of UL 1277 and NEC Type TC.

6. Acceptable Manufactures:

a. Belden

b. Alpha Wire

c. Approved equal

E. Multi Conductor Power, Control, and Instrumentation Cable 600 Volts and Less:

1. General: Provide cable that is UL listed and conforms to the requirements of the NEC Type TC, or UL listed Power Limited Circuit Cable that conforms to the requirements of Article 725 of the National Electrical Code where applicable. Provide cables permanently and legibly marked with the manufacturer's name, the maximum voltage rating for which the cable was tested, the type of cable, and labeled UL (or submit evidence of UL listing).

2. 600 Volt Multi Conductor Control Cable

a. General: Multi conductor control circuit interconnection cable with integral ground. Suitable for installation in open air, cable tray, conduit, wireway, direct buried or other approved raceways. Minimum cable temperature rating 90 degrees C dry and wet locations. Provide cable with size and number of conductors as shown on the Drawings or Schedules

b. Individual Conductors: Class B stranded copper per ASTM B-8.

c. Insulation and Jackets: Provide cross linked polyethylene insulated conductors UL listed per UL 1581 as Type XHHW-2. Outer PVC jacket shall be flame resistant, sunlight and oil resistant.

d. Color code the conductor groups in accordance with ICEA S-61-402, Appendix K, Method 1, E 2.

e. Acceptable Manufacturers:

1) Okonite – X-Olene

2) Southwire

3) General Cable

4) Approved equal

3. 600 Volt, Twisted, Shielded Pair Instrumentation Cable:

a. General: Type TC, single pair instrumentation cable designed for noise rejection for process control, computer, or data log applications. Suitable for installation in conduit, wireway, or other approved raceways. Minimum cable temperature rating shall be 90°C dry locations, 75°C wet locations.

b. Individual Conductors: No. 16 AWG stranded bare annealed copper, Class B, 7 strand concentric per ASTM B-8, size as indicated on the drawings; 7 strand tinned copper drain wire.

c. Insulation and Jacket: Each conductor 15 mil nominal PVC and 4 mil nylon insulation. Pair conductors pigmented black and red. Jacket flame retardant and sunlight and oil resistant PVC with 45 mil nominal thickness. Aluminum/polyester shield overlapped to provide 100 percent coverage.

d. Acceptable Manufacturers:

1) Belden No. 9342

2) Alpha Wire Company

3) Okonite

4) Approved equal

4. 600 Volt Multi Twisted Shielded Pairs with a Common Overall Shield Instrumentation Cable:

a. General: Type TC, twisted, shielded pairs of instrument cables, grouped in a single cable, designed for use for instrumentation, process control, and computer applications. Suitable for installation in conduit, wireway, or other approved raceways. Minimum cable temperature rating shall be 90°C dry and wet locations.

b. Conductors: No. 16 stranded bare annealed copper, Class B, 7 strand, concentric per ASTM B-8. Tinned copper drain wires sized as shown on the Drawings, one for each pair and one for the overall group.

c. Insulation and Jacket: Each conductor 15 mil PVC and 4 mil nylon insulation Outer jacket flame retardant and sunlight and oil resistant PVC with 45 mil minimum thickness. Individual pair shield aluminum/polyester. Group shield aluminum/polyester, overlapped for 100 percent coverage.

d. Pair conductors pigmented black and red or black and white, with red or white conductor numerically printed for group identification.

e. Acceptable Manufacturers:

1) Belden No. 1041A

2) Okonite

3) Approved equal

F. Category 6 Unshielded Twisted Pairs:

1. General: industrial grade Category 6 Unshielded Twisted Pairs (UTP) suitable for use in harsh environments as industrial Ethernet cable, 600 MHz Enhanced Category 6, Gigabit Ethernet, 100BaseTX, NTSC/PAL Component or Composite Video, RS-422, RJ-45 compatible, suitable for outdoor use and installation in conduit and other approved raceways.

2. Conductors: 4 pairs of conductors, 8 conductors total, 23 AWG solid bare copper conductors.

3. Insulation and Jacket: polyolefin insulation, individual conductors colored white/green and green, white/orange and orange, white/blue and blue, and white/brown and brown, center strength member, unshielded, industrial grade sunlight and oil resistant PVC jacket, outer jacket ripcord, 0.251 x 0.339 inch overall nominal diameter, 300 volts, -40 degrees C to +75 degrees C operating temperature.

4. Applicable Standards: NEC/UL CMR, UL Style 444, ANSI/TIA/EIA-568-B.2-1 CAT 6, UL Verified to Category 6, UL 1666 Riser Flame Test.

5. Acceptable Manufacturers:

a. Belden 7927A

b. Approved equal

G. 6/C RS-485:

1. General: industrial low-capacitance shielded cables for EIA RS-485 applications, including security access card readers, suitable for outdoor use and installation in conduit and other approved raceways.

2. Conductors: 3 pairs of conductors, 6 conductors total, 22 AWG, 7 strand tinned copper conductors.

3. Insulation: foam high density polyethylene insulation, pairs colored white/blue and blue/white, white/orange and orange/white, white/green and green/white.

4. Shield: aluminum foil polyester tape providing 100 percent coverage, tinned copper braid providing 90 percent coverage, 7-strand tinned copper 24 AWG drain wire.

5. Jacket: UV and oil resistant PVC, 0.420 inch overall nominal diameter, 300 volt, -20 degrees C to +60 degrees C operating temperature.

6. Applicable Standards: NEC/UL CM and PLTC OIL RES II, UL 1685 Flame Test, UL 1581 Sunlight Resistance Test.

7. Acceptable Manufacturers:

   a. Belden 3108A

   b. Approved equal

H. Category 6 Nonbonded-Pair Cable:

1. General: Provide Category 6A Unshielded Twisted Pairs (UTP) suitable for use as premise horizontal cable, both plenum rated and riser rated, 10 Gigabit Ethernet cable, 100BaseTX, 100BaseVG ANYLAN, 155ATM, 622ATM, NTSC/PAL Component or Composite Video, AES/EBU Digital Audio, AES51, RS-422, noisy environments, PoE, suitable for installation in conduit and other approved raceways.

2. Conductors: 4 pairs of conductors, 8 conductors total, 23 AWG solid bare copper conductors.

3. Insulation and Jacket: polyolefin insulation, individual conductors colored per TIA 568B Standard color code, center strength member, unshielded, industrial grade sunlight and oil resistant PVC jacket, outer jacket ripcord, 0.295 inch overall nominal diameter, 300 volts, -20 degrees C to +60 degrees C operating temperature.

4. Performance: 10 Gigabit Ethernet across a 500 MHz frequency range.

5. Applicable Standards: NEC/UL CMR, TIA 568-C.2, ISO/IEC 11801 Class EA, UL 1666 Vertical Riser Flame Test.

6. Acceptable Manufacturers:

   a. Belden 10GX

   b. Mohawk XGO F/UTP

   c. Approved equal

I. Industrial Ethernet Passive Components:

1. Provide connectors, sockets, and couplings suitable for use in industrial Ethernet applications for 10 Gigabit Ethernet data transmission.

2. Components shall be rated for IP20 and IP67 class of protection in accordance with IEC 529.

3. Equipment shall be designed to withstand harsh industrial environments including high temperatures and damp locations. Housings shall be resistant to dirt and liquids.

4. Applicable Standards: NEC/UL CMR, TIA 568-C.2, ISO/IEC 11801 Class EA, UL 1666 Vertical Riser Flame Test.

5. Acceptable Manufacturers:

   a. Phoenix Contact PLUSCON data

   b. Weidmuller Steady Tec

   c. Approved equal

J. Flexible Cords, Cables, and Fittings:

1. Where flexible cords and cables are required, provide Type SO, 600-volt, having the number and size of copper conductors shown on the Drawings.

2. Provide liquid-tight strain relief fittings for exposed flexible cord and power cable where cables enter electrical panels and enclosures. Provide strain relief as manufactured by Hubbell (Kellums), OZ Gedney, or approved equal

K. Electrical Tape for Color Coding:

1. Electrical tape shall be premium grade, not less than 7 mils thick, rated for 90 degree C minimum, flame-retardant, weather resistant, and available in suitable colors for color coding. The tape shall be resistant to abrasion, ultraviolet rays, moisture, alkalies, solvents, acids, and suitable for indoor and weather-protected outdoor use. The tape shall be suitable for use with PVC and polyethylene jacketed cables, and meet or exceed the requirements of UL 510.

2. Acceptable Manufactures:

   a. 3M 35 Scotch Vinyl Electrical Tape for Color Coding

   b. Plymouth Rubber Company Premium 37 Color Coding Tape

   c. Approved equal

L. Low Voltage Splices, 600 volts and below:

1. Power Conductors

   a. General: Provide low voltage splices consisting of 600 volt compression type connectors and connector insulators, suitable for indoor and outdoor field installations.

   b. Provide two way, uninsulated, compression connectors, long barrel type, suitable for use with stranded copper conductors. Provide UL listed connectors rated 600 volts minimum. Acceptable manufacturers: Burndy, Thomas and Betts, Panduit, or approved equal.

c. Connector insulators shall be cold shrink type factory expanded and assembled tubular EPDM rubber sleeves, suitable for field installation. Insulators shall shrink over in line connections, forming a water proof seal. Provide insulators rated for 1000 volts, minimum.

d. Acceptable manufacturers:

1) 3M

2) Approved equal

2. Control Conductors

a. Insulated compression type connectors shall be of the expanded vinyl insulated parallel or pigtail type as manufactured by Ideal Industries; 3M Co.; Panduit Corp. or approved equal.

b. Solderless pressure connectors shall be self-contained, waterproof and corrosion-proof units incorporating prefilled silicone grease to block out moisture and air. Connectors shall be sized according to manufacturer's recommendations. The connectors shall be UL listed and CSA approved, as manufactured by King Technology, St Louis, MO; Ideal Industries, Inc., Sycamore, IL or approved equal.

M. Low Voltage Terminations, 600 volts and below:

1. Power Conductors

a. Provide solderless, die type or set screw compression type lugs and connectors. Provide plated copper alloy terminations as manufactured by Thomas and Betts; Burndy; or approved equal. Provide lugs and connectors recommended by the manufacturer for the cable type used.

b. Motor connections shall be screw type insulated pressure connections terminations installed on the branch circuit wires and the motor leads and secured with bolt, nut and springwasher. Provide insulation by heat shrink boot especially made for motor termination use. Wire nuts, split bolts, etc., are not acceptable. Connections shall be insulated with a Raychem Type MCK, roll-on stub insulator or approved equal and shall be as recommended by the manufacturer for the cable type used.

2. Control, Status, and Alarm Conductors

a. Termination connectors shall be of the locking fork-end (upturned leg ends) type as manufactured by Ideal Industries; 3M Co.; Panduit Corp. or approved equal.

3. Instrumentation Cables

a. Termination connectors shall be of the locking fork-end (upturned leg ends) type as manufactured by Ideal Industries; 3M Co.; Panduit Corp. or approved equal.

N. Wire and Cable Markers

1. Wire and cable markers shall be pre-printed, clip sleeve type as manufactured by the W.H. Brady Co.; Thomas & Betts Co.; 3M Co. or approved equal.

2. Wire and cables with diameters exceeding the capacity of the clip sleeve type shall be marked with pre-printed, self-adhesive vinyl tapes as manufactured by the W.H. Brady Co.; Panduit Corp. or approved equal.

2.2 BUS DUCT

A. Ratings

1. Provide non-segregated bus assemblies with bus duct voltage and current ratings as indicated on the Contract Documents.

2. The bus duct shall have a minimum of 6-cycle short-circuit rating of 85 kA RMS symmetrical for ratings through 800 Amp, 100 kA RMS symmetrical for ratings through 1350 Amp, 125 kA RMS symmetrical for ratings through 1600 Amp, 150 kA RMS symmetrical ratings through 2500 Amp, and 200 kA RMS symmetrical for ratings through 5000 Amp.

B. Equipment

1. The entire bus duct housing, including indoor sections, shall be copper, totally enclosed and ventilated, with louvered top and bottom covers. Enclosure shall be designed for a maximum temperature rise of 45°C when carrying rated current in a 45°C ambient.

2. For outdoor installation, the bus duct shall include weatherproof coverings suitable for outdoor applications. Splice plates and joint covers shall have neoprene gaskets to seal out all water and shall have removable rubber drain plugs. Drain plugs located on the underside of the duct shall be removed by the Contractor to permit drainage.

3. High strength plated steel hardware shall supplied for bus joints including lockable and flat washers. Belleville spring washers shall be furnished. Bus joints shall permit safe, practical testing of its tightness without deenergizing the run. Access to only one side of the duct shall be required for tightening or inspection of the joint. Any one section of the duct shall be removable without disturbing adjacent sections. Joint covers shall be provided with captive hardware.

4. Bus bars shall be fabricated from high strength, 90 percent conductivity copper and tin plated. Bus bars shall be insulated over their entire length, except at joints and contact surfaces, with an UL listed insulating material consisting of PVC applied by fluidized bed process. Sheets of polyester (Mylar) film shall be placed between bus bars and between bus bars and the housing.

5. The bus duct shall meet the latest applicable standards of NEMA BU.1 and UL 857.

6. Provide manufacturer’s standard bus duct fittings, connectors, and terminations for cable tap boxes and at switchgear enclosures.

7. The rating, characteristic and material used for the bus duct shall be the same as the existing bus entering SWGR-A. Existing busduct is General Electric, Spectra Series with copper bussing 3 Phase, 4 Wire, and rating as shown on the Drawings. UL short circuit ratings shall apply to all bus duct system including the associated fittings such as straight lengths, elbow, tees, tap boxes, power takeoffs and plugs which are necessary for bus duct installation. Drawings of the existing equipment are available from the City upon request after Notice to Proceed.

8. Where the bus duct enters and exits at the switchgear enclosure, provide suitable flange type entrance fitting. Provide UL listed fire-stop barrier matching the fire rating of the enclosure where penetrations are required.

C. Acceptable Manufacturers

1. General Electric Co., Spectra Series

2. Schneider Electric/Square D

3. Delta/Unibus a subsidiary of Powell Industries, Inc.

4. or equal

PART 3 EXECUTION

3.1 GENERAL

A. Use lubrications to facilitate wire pulling. Lubricants shall be UL approved for use with the insulation specified.

B. Do not exceed cable manufacturer's recommendations for maximum pulling tensions and minimum bending radii. Pulling of cable shall be performed in such a manner that the cable outer jacket does not scrape against the edge of the conduit, at both the inlet and outlet ends of the conduit. Cable shall be free of sandy or gritty material during pulling. If cable is laid on ground during pulling, cable shall be wiped free of sandy or gritty material prior to entry of cable into conduit and prior to application of any pulling compound.

C. Tighten all screws and terminal bolts using torque type wrenches and/or drivers to tighten to the inch pound requirements of the NEC and UL.

D. Where single conductors and cables enter manholes, handholes, vaults, and other indicated locations bundle the conductors from each conduit throughout their exposed length with nylon, self locking, releasable, cable ties placed at intervals not exceeding 18 inches on centers.

E. Wrap exposed lengths of 480V feeders in manholes or handholes, #4/0 and higher, with fire proof tape.

F. Terminate no more than two control conductors per terminal point. Terminate all spare conductors on terminal blocks.

G. When pulling low voltage power and control conductors in the same conduit, only combine conductors with no more than two wire sizes difference to prevent possible installation damage to the smaller conductors; otherwise use separate conduits.

H. Uniquely identify all wires, cables and each conductor of multi-conductor cables (except lighting and receptacle wiring) at each end with approved wire and cable marker systems as specified under Section 16000.

I. Monitor pulling tensions while pulling on runs between manholes and handholes and record the maximum tensions used. Advise the Engineer of cases exceeding the manufacturer's recommendations and remove and replace cables subjected to tensions in excess of those recommended.

3.2 CONDUCTOR 600 VOLTS AND BELOW

A. Provide conductor sizes indicated on schedules with no splices except as approved in writing by the Engineer.

B. Multiconductor control and signal cables or individual conductors may be used at the discretion of the Contractor. Individual conductors are indicated on the conduit schedule.

C. Wire nuts may be used only on 120 volt lighting and 120 volt receptacle circuits. Place no more than one conductor in any single-barrel pressure connection. Use crimp connectors with tools by same manufacturer and/or UL listed for connectors of all stranded conductors. Soldered mechanical joints insulated with tape will not be acceptable.

D. Color coding on wire sizes larger than No. 6 AWG shall be by taping the individual conductors with the appropriate colored self adhesive vinyl electrical tape.

E. Provide terminals and connectors recommended by the manufacturer for the type of material used.

F. Arrange wiring inside control panels, motor starters, switchgear. etc., neatly cut to proper length, remove surplus wire, and bridle and secure in an acceptable manner. Identify all circuits entering switchgear, motor starters, control panels, etc., in accordance with the cable schedules on the drawings. Terminate cable conductors on the same side of the terminal blocks as shown on the drawings.

G. Terminations for power conductors shall be die type or set screw type pressure connectors as specified. Splices for power conductors if specifically requested by the Contractor and approved in writing by the Engineer, shall be die type compression connector and waterproof with shrink fit rubber boot (as specified) or epoxy filling for copper conductors # 4 AWG and larger. Splices shall be solderless pressure connectors with insulating covers for copper conductors # 6 AWG and smaller. Approved splicing shall be performed only in enclosures approved for splicing in the NEC.

H. Terminate control and instrumentation wiring with methods consistent with terminals provided, and in accordance with terminal manufacturer's instructions. Where terminals provided will accept such lugs, terminate all control and instrumentation wiring (except solid thermocouple leads) with insulated, locking fork compression lugs. Control panel incoming field wireway sizes indicated on the Drawings are considered minimum. Contractor shall adjust wireway sizes to meet NEC percentage fill requirements.

I. For terminals designed to accept only bare wire compression terminations use only stranded wire, and terminate only one wire per terminal. For control and instrumentation cables use ferrule on ends of wire. For cables terminating on terminal blocks, also use ferrule type. Tighten all terminal screws with torque screwdriver to recommended torque values.

J. Attach compression lugs with a tool specifically designed for that purpose which provides a complete, controlled crimp where the tool will not release until the crimp is complete. Use of plier type crimpers is not acceptable.

K. Where conductors pass through holes or over edges in sheet metal, remove all burrs, chamfer all edges, and install bushings and protective strips of insulating material to protect the conductors.

L. For conductors that will be connected by Others, provide at least six feet spare conductor in freestanding panels and at least two feet spare in other assemblies. Provide sufficient spare conductor length in any particular assembly as required to reach the termination point plus an additional two feet of slack conductor.

M. Cables passing through manholes and handholes shall be trained along the walls on cable racks. Allow two feet of slack in each run in a "drip loop" at least once along a wall. Loops and cables shall be organized, trained, bundled, and neatly installed.

N. Do not strip cables more than eight inches from the nearest termination point of that cable.

O. Cap spare conductors and conductors not terminated with UL listed end caps.

P. All spare pairs shall be bundled and labeled with the cable designation. All individual pairs shall be tagged to enable identification of spare pairs when making future terminations.

Q. Splices will not be permitted except as accepted in writing by the Engineer.

R. Ends of cable shall not be exposed to the ambient environment more than 24 hours after pulling or splicing. After 24 hours the cable shall be purged with nitrogen or sealed with tape.

3.3 MULTI-CONDUCTOR POWER, CONTROL, AND INSTRUMENTATION CABLES 600 VOLTS AND LESS

A. All circuits shall be installed as twisted pairs or triads. In no case shall a circuit be made up using conductors from different pairs or triads. Triads shall be used wherever three wire circuits are required.

B. Terminal blocks shall be provided at all instrument cable junction and all circuits shall be identified at such junctions. Direct splicing of signal and instrumentation circuits is not acceptable. Shielded instrumentation wire, coaxial, data highway, I/O and fiber optic cables shall be run without splices between instruments, terminal boxes, or panels.

C. Shields shall be grounded as recommended by the instrument manufacturer and isolated at all other locations. Terminal blocks shall be provided for inter-connecting shield drain wires at all junction boxes. Where individual circuit shielding is required, each shield circuit shall be provided with its own block.

3.4 BUS DUCT

A. Furnish and install bus duct as shown on the Drawings and as specified herein, including all necessary fittings, hangers, weather barriers and accessories. The bus duct housing shall be non-ventilated and capable of being mounted in any position without derating. The bus duct shall consist of standard 10-ft sections with special sections and fittings provided to suit the installation. Horizontal runs shall be hung on 5-ft maximum support centers. On vertical runs one adjustable vertical hanger per floor shall be supplied.

B. Provide seismic bracing, hardware, anchors, and restraints for the bus duct as required under the seismic calculations as specified herein and as recommended by the manufacturer.

C. Bus duct testing shall be performed as specified in Section 16080.

3.5 LACING OF WIRES AND CABLES

A. All wires and cables shall be laced in pull or junction boxes, manholes, handholes, wireways, and at each termination. Wires and cables shall be laced so that the wires of the individual circuits are laced together by circuit and the laced together circuit or cable shall be tagged with the cable number. All wiring entering and exiting the control panels shall be bundled into groups. Power, lighting, control, alarm, and instrumentation wiring shall be bundled and laced as specified herein.

3.6 FIELD QUALITY CONTROL

A. Provide acceptance testing of all of the low voltage cables per Section 16080.

B. Coordinate system loop checking including point to point cable continuity checking and verification in conformance with the requirements of Section 13300.

C. All data highway and special systems cabling shall be tested as required by the system manufacturer requirements. Testing shall be performed as specified in the individual Division 13 or Division 16 sections to verify satisfactory signal transmission and reception in conformance with manufacturer's published requirements.

3.7 SPARES

A. Identify spare conductors with source location and other identifiers as shown on the Drawings. Provide a minimum of 5-feet of extra conductors for each spare circuit. Wrap excess conductor lengths, provide with plastic tie-wrap, and coil up in last pullbox location of the run.

END OF SECTION

SECTION 16121 – MEDIUM VOLTAGE CABLES

PART 1 GENERAL

1.1 DESCRIPTION

A. Furnish and install medium voltage cables, terminations, splices, and accessories as shown on the Drawings and as specified herein. The term “medium voltage” shall mean above 600V and below 34.5 kV.

B. This Section shall apply to all temporary and permanent medium voltage feeders used on the project.

C. This Section shall apply to all temporary and permanent medium voltage feeders used on the project.

1.2 RELATED SECTIONS:

A. Section 16000 – Common Work Results for Electrical.

B. Section 16060 – Grounding and Bonding for Electrical Systems.

C. Section 16080 – Electrical System Analyses and Acceptance Testing.

1.3 SUBMITTALS

A. Submit shop drawings and samples in accordance with Section 01340 and Section 16000.

B. Submit product data for conductor types, termination materials, splice kits, and wire and cable marking systems.

C. Submit samples of proposed cables. Each submitted sample portion shall include the manufacturer, size, type of insulation, listing information, and voltage rating stenciled on the jacket.

D. Approved samples will be sent to the project location for comparison by the Engineer with the wire actually installed. Installed unapproved wire shall be removed and replaced at no additional cost to the City.

E. Submit shop test results and certified proof of compliance with ICEA design and test standards.

F. Submit field test results for testing as specified herein and in Section 16950.

1.4 REFERENCES

A. Where reference is made to one of the following standards, the revision in effect at the time of bid opening shall apply.

B. Association of Edison Illuminating Companies (AEIC)

1. AEIC CS5 – Cross-Linked Polyethylene Insulated Shielded Power Cables

2. AEIC CS6 – Specifications for Ethylene Propylene Rubber Insulated Shielded Power Cables Rated 5 Through 69 KV

C. American National Standards Institute (ANSI)

1. ANSI C 119.2 – Separable Insulated Connectors for Power Distribution Systems Above 600V.

D. American Society for Testing and Materials (ASTM)

1. ASTM B-3 – Standard Specification for Soft or Annealed Copper Wire.

2. ASTM B-8 – Specification for Concentric-Lay-Stranded Copper Conductors, Hard, Medium-Hard, or Soft.

3. ASTM B-496 – Standards for annealed uncoated copper compact stranded.

E. Institute of Electronic and Electrical Engineers (IEEE):

1. IEEE 48 – Standard Test Procedures and Requirements for Alternating-Current Cable Terminations 2.5 kV Through 765 kV

2. IEEE 383 – IEEE Standard for Type Test of Class 1E Electric Cables, Field Splices and Connections for Nuclear Power Generating Stations

3. IEEE 400 – IEEE Guide for Field Testing and Evaluation of the Insulation of Shielded Power Cable Systems

4. IEEE 404 – IEEE Standard for Extruded and Laminated Dielectric Shielded Cable Joints rated 2500 V to 500 000 V

5. IEEE 1202 – IEEE Standard for Flame Testing of Cables for Use in Cable Tray in Industrial and Commercial Occupancies

F. Insulated Cable Engineers Association (ICEA)

1. ICEA S-93-639/NEMA WC74 – 5-46 kV Shielded Power Cable for Use in the Transmission & Distribution of Electrical Energy

G. National Electrical Code (NEC)

1. Article 310 – Conductor for General Wiring.

2. Article 326 – Medium Voltage Cable: Type MV.

H. National Electrical Manufacturers Association (NEMA)

1. NEMA WC 8, Ethylene-Propylene- Rubber-Insulated Wire and Cable for the Transmission and Distribution of Electrical Energy

I. Underwriters Laboratory (UL)

1. UL 510 – Standard for Safety Polyvinyl Chloride, Polyethylene, and Rubber Insulating Tape.

2. UL 1072 – Standard for Medium-Voltage Power Cables.

J. Field testing and commissioning shall be done in accordance with the latest revision of the "Acceptance Testing Specifications for Electrical Power Distribution Equipment and Systems" published by the International Electrical Testing Association (NETA Standard ATS) unless otherwise modified by this Section.

1.5 QUALITY ASSURANCE

A. The general construction of the cable and the insulation material used shall be similar to that used for cable of the same size and rating in continuous production for at least 15 years and successfully operating in the field in substantial quantities.

B. The general construction of the cable and the insulation material used shall be similar to that used for cable of the same size and rating in continuous production for at least 15 years and successfully operating in the field in substantial quantities.

C. The manufacturer shall have available for audit detailed descriptions of the method by which his various manufacturing processes and production test are recorded, thus enabling the "traceability" of the completed cable. All steps in the manufacturing process, from receipt of raw material to the final tests, are to be included. Where multiple records are used, the method for cross-referencing shall be noted.

D. Cable shall be UL listed per UL 1072.

E. The manufacturer of cable terminations and splice systems shall have a minimum of 5 years successful field experience as well as demonstrated technical life assessment. The termination and splicing system manufacturer shall have an established and documented Quality Assurance Program implementing suitable procedures and controls for all activities affecting quality. The program shall provide documentation that verifies the quality of production termination and splice kits and traceability back to inspection records, raw material and the original designs and design proof tested products.

F. Splicing and terminating shall be performed by electricians having at least 80 hours of formal training and a minimum of 5 years field experience in this type of work. Qualifications shall be submitted to the Engineer upon request.

1.6 CONDUCTOR COLOR CODING

A. Color coding of multiconductor control and instrumentation cable is specified in the individual cable type specification.

B. For power conductors, provide all single conductors and individual conductors of multiconductor power cables with integral insulation pigmentation of the designated colors, except conductors larger than No. 6 AWG may be provided with color coding to indicate phase A, B or C by wrapping the conductor at each end and at all accessible locations with vinyl tape. Where this method of color coding is used, wrap at least six full overlapping turns of tape around the conductor covering an area 1 1/2 to 2 inches wide at a visible location at all conductor termination and pulling points.

C. Phase A, B, C implies the direction of positive phase rotation.

D. Use the following colors:

System	Conductor	Color
All Systems	Equipment Grounding	Green
22 kV	Cable Phasing	Identify by tagging each phase after taping has been completed
	Phase A	Brown
	Phase B	Orange
	Phase C	Yellow

1.7 DELIVERY, STORAGE AND HANDLING

A. All conductor ends shall be sealed at the factory, and these seals shall be intact when the conductors are delivered. When delivered, provide the Engineer with certified test reports verifying that the supplied conductors passed applicable AEIC CS6 and ICEA tests.

B. Seal cable ends with heat shrinkable end caps. Remove end caps only when cables are installed and ready to be terminated.

C. Check for reels not completely restrained, reels with interlocking flanges or broken flanges, damaged reel covering or any other indication of damage.

D. Inspect the reels as they are unloaded from the delivery truck, any visible damage shall be reported by the Contractor and the reel returned to the factory.

E. Provide a crane, special lift truck, sling and spreader bar, or forklift to unload the cable reels. Reels shall not be dropped from any height. Roll reels in the direction of the arrows shown on the reel and on surfaces free of obstructions or debris that could damage the cable.

F. Cables shall be packaged on spools or reels. Each package shall contain only one continuous length of cable. The packaging shall be constructed so as to prevent damage to the cable during shipping and handling.

G. Store cable on a solid, well drained location. Store unjacketed armored cable indoors. Cover cable reels with plastic sheeting or tarpaulin. Do not lay reels flat.

H. Storage of cable after pulling or splicing shall include purging of entire cable with nitrogen or otherwise seal with tape at both ends.

I. Provide the Engineer with copies of the original X Y plots showing discharge levels recorded during the corona discharge test performed per AEIC requirements on the conductors supplied.

1.8 SHOP TESTING

A. Perform manufacturers standard production testing and inspection in accordance with Section 6 of the referenced ICEA standards. The manufacturer shall submit certified proof of compliance with ICEA design and test standards.

B. Provide certified test reports indicating that the cable has passed the following tests:

1. Partial Corona Discharge Test in accordance with AEIC CS5/6, Section G.

2. Vertical tray flame test in accordance with IEEE 1202.

C. After completion of the factory tests, individual pulling eyes shall be installed on single or triplexed conductor length of cable. Pulling eyes shall be suitable for maximum allowable pulling tension on the conductors and they shall be sealed against entrance of water.

1.9 WARRANTY

A. The cable manufacturer shall warrant the cable against failures for a period of 5 years from date of installation and shall remove and replace failed cables at the cable manufacturer's expense during this warranty period.

PART 2 PRODUCTS

2.1 GENERAL

A. The manufacturer's name, the voltage class, type of insulation, thickness of insulation, conductor size, UL listing and date of manufacture shall be printed on the jacket.

B. Cables shall be suitable for use in wet or dry locations, indoor or outdoor, in non-metallic or metallic conduits, underground duct systems and direct buried installation.

C. Cables shall be able to operate continuously at 105 degrees C conductor temperature, with an emergency rating of 140 degrees C and a short circuit rating of 250 degrees C. Emergency overloads shall be possible for periods of up to 100 hours. Five 100 hours emergency overload operations within the life time of the cable shall be possible.

D. Cable Ratings and Type

1. 21 kV Cable

a. Cable type: Single conductor.

b. Cable rating: 25 kV, 133% insulation level.

c. Operating voltage: 21 kV (nominal), 3 phase, 60 Hz, grounded distribution system.

d. UL listed: MV-105

E. Medium voltage cable shall be shielded.

F. Medium voltage cables shall have the following physical characteristics conforming to the applicable requirements of ICEA S-93-639/NEMA WC74 and S-97-682, AEIC CS8, and UL 1072 and other requirements specified below:

1. Conductors: Uncoated, copper, Class B concentric lay, compact stranded per ASTM B496.

2. Strand Screen: Extruded semiconducting EPR stress control layer.

3. Insulation: Thermosetting ethylene propylene rubber (EPR) compound.

4. Insulation Screen: The insulation shield shall consist of a layer of semi-conducting EPR material extruded directly over the insulation.

5. The semiconducting layers and insulation shall be applied using a triple extrusion process.

6. Screens shall be clean stripping.

G. Cable Shielding System

1. Metallic Shield: 5 mil bare copper tape helically applied with a nominal 12.5 percent overlap nominal.

H. Cable Jacket

1. Provide an overall, moisture, heat, abrasion, UV and ozone resistant jacket over the metallic shield. Jacket material shall be polyvinyl chloride (PVC). Sunlight resistance shall conform with the requirements of UL 1072.

I. Acceptable manufacturers:

1. Okonite Company, Inc.

2. General Cable Co.

3. Hubbell/Kerite Company, Inc.

4. Approved equal

2.2 CABLE ACCESSORIES

A. Provide terminators rated in accordance with IEEE 48, Class 1 and Class 2 as specified.

1. Provide terminations consisting of a high dielectric constant stress control tube insulated with a nontracking silicone rubber insulator, prestretched and loaded together onto a removable core.

2. Provide heat shrink type cable terminations in factory engineered kit form, suitable for proper termination of cables specified in this Section. Kits shall be compatible with MV-105 cable rated for 105 degrees C normal operating temperature and 140 degrees C emergency overload temperature. Provide skirted EPDM type or preassembled porcelain slip-on type for outdoor terminations.

3. For all terminations provide proper shield termination and grounding suitable for single conductor, EPR insulated and shielded cable of the size indicated on the drawings. Provide all necessary mounting hardware, covers, and connectors.

4. For cable to bus connection kits, provide heat-shrinkable insulating tubing and sealant strips for insulating and environmentally sealing medium-voltage in-line cable to busbar connections.

5. IEEE 48, Class 1 Termination: Porcelain insulator or molded EPDM, suitable for outdoor use.

6. IEEE 48, Class 2 Termination: Porcelain or molded rubber insulator and suitable for use inside an outdoor rated enclosure.

7. Acceptable Manufactures:

   a. Conductor Termination Kits: Thomas and Betts (Elastimold), Type Ranger 2; 3M, Type QTIII; Tyco (Raychem), Type HVT-Z; DSG-Canusa; or Approved Equal.

   b. Cable to Bus Connection Kit: Tyco (Raychem) Type HVBC or Approved Equal.

   c. Single conductor 25/35 kV shielded cable terminations for indoor or outdoor applications shall be Thomas and Betts (Elastimold), 35 MTG Series; DSG-Canusa; or approved equal.

B. Cable Splices

1. All material used in splicing medium voltage cables shall be as recommended by the cable manufacturer. Cable splice kits shall consist of materials which are completely compatible with the conductors, insulations, shields, and jackets of the medium voltage cable system. Each splice kit shall contain cable preparation kit, ground strap, solder, semi-conducting tape, high voltage rubber insulating tape and vinyl plastic tape. Cables shall be spliced in accordance with the kit supplier's drawings.

2. EPR insulated cable splices shall be water tight, hand wrapped, and shall meet or exceed the requirements of IEEE 404.

3. Tape Shielded Inline and Tee Cable Splice: Cable splices shall be made in accordance with splice drawings furnished by the cable manufacturer.

4. Cable splicing material shall be as manufactured by Raychem; 3M Corp.; Elastimold; or approved equal.

C. Lugs and Connectors

1. Copper lugs and connectors shall be crimped with standard industry tooling. All connections of copper stranded wire through 1000 kcmil shall be made electrically and mechanically secured. The lugs and connectors shall have a current carrying capacity equal to the conductors for which they are rated and meet UL 486 requirements. Lugs larger than 4/0 AWG shall be two-hole lugs with NEMA spacing. The lugs and connectors shall be rated for operation at the system voltage on which they are applied. The lugs shall be of closed end construction to exclude moisture migration into the cable conductor.

D. Flexible Cord and Cable Sealing Fittings:

1. Provide liquid-tight strain relief connectors for exposed flexible cord and power cable where cables enter electrical panels and enclosures. Connectors shall be OZ Gedney, Hubbell, Appleton, or approved equal.

E. Electrical Grounding Braid

1. Conducting metal braid shall be woven from 240 strands of 30 AWG tinned copper wires and be capable of carrying fault current comparable to that of 6 AWG copper wire, 3M Corp., Scotch brand 25 or approved equal.

2.3 MEDIUM VOLTAGE CONDUCTOR ARC AND FIREPROOFING MATERIALS

A. Arc and fireproofing tape: Arc and fireproofing tape shall consist of a flexible conformable unsupported elastomer. The tape shall be not less than 30 mils (0.030 inches) thick and be capable of over 100 percent elongation. The tape shall be non-corrosive to metallic cable sheaths and compatible with synthetic cable jackets such as hypalon (CSPE) and PVC. The tape shall be self-extinguishing and shall not support combustion. The tape shall not deteriorate when subjected to water, salt water, gases, and sewage.

1. Acceptable Manufactures:

a. 3M Scotch 77 Fire and Arc Proofing Tape.

b. Plymouth Rubber Company 53 Plyarc Arc and Fire Proofing Tape.

c. Approved equal

B. Glass Cloth Electrical Tape: Glass cloth electrical tape shall consist of a woven glass fabric tape with a thermosetting rubber based pressure sensitive adhesive. The tape shall be not less than 7-mils (0.007 inches) thick, and shall have high tensile strength.

1. Acceptable Manufactures:

a. 3M Scotch 69 Glass Cloth Electrical Tape.

b. Plymouth Rubber Company 77 Plyglas Pressure Sensitive Glass Cloth Tape

c. Approved equal

2.4 CABLE MARKING SYSTEMS

A. Provide cable tags of heat stamped nylon secured by polypropylene cable ties, Thomas & Betts No. TC228-9, or approved equal.

B. Phase Identification

1. Electrical tape shall be premium grade, not less than 7 mils thick, rated for 90 degree C minimum, flame-retardant, weather resistant, and available in suitable colors for color coding. The tape shall be resistant to abrasion, ultraviolet rays, moisture, alkalies, solvents, acids, and suitable for indoor and weather-protected outdoor use. The tape shall be suitable for use with PVC and polyethylene jacketed cables, and meet or exceed the requirements of UL 510.

2. Acceptable Manufactures:

a. 3M 35 Scotch Vinyl Electrical Tape for Color Coding.

b. Plymouth Rubber Company Premium 37 Color Coding Tape.

c. Approved equal

2.5 PULLING COMPOUNDS

A. Pulling compound shall be nontoxic, nonflammable, noncombustible and noncorrosive. The material shall be UL listed and compatible with the cable insulation and jacket.

B. Acceptable manufacturers are Ideal Company; Polywater, Inc.; Cable Grip Co. or approved equal.

PART 3 EXECUTION

3.1 GENERAL

A. Do not exceed cable manufacturer's recommendations for maximum pulling tensions and minimum bending radii. Where pulling compound is used, use only UL listed compound compatible with the cable outer jacket, voltage rating, and with the raceway involved.

B. Make use of the field engineering services available from the cable manufacturer for performing pulling calculations, installation guidelines, and recommendations on installation procedures.

C. Determine the cutting lengths, reel arrangements and total lengths of cable required based on the physical layout of conduit and ductbanks shown on the Drawings. Furnish cutting length data to the cable manufacturer as soon as possible to assure on-time delivery of cable.

D. Submit a schedule of cable pulls 2 weeks prior to installation and certify in writing that the cable will meet the requirements of the cable manufacturer for maximum pulling tension, allowable sidewall pressure, and installed bending radius limitations.

E. Cables shall not be installed into raceways until the Contractor prepared pulling calculations are reviewed by the Engineer and returned marked as “No Exceptions Noted.”

F. When temperature is below 50 degrees F, cable reels shall be stored at 70 degrees F for at least 24 hours before installation. Test cables for internal moisture prior to being pulled.

G. Pull cables from direction that requires the least tension and based on the submitted and approved pulling calculations. Feed cables into raceway with zero tension and without cable crossover at raceway entrance.

H. Monitor pulling tensions using a dynometer while pulling on runs between manholes and handholes and record the maximum tensions used. Advise the Engineer of cases exceeding the manufacturer's recommendations and remove and replace cables subjected to tensions in excess of those recommended.

I. Pulling of cable shall be performed in such a manner that the cable outer jacket does not scrape against the edge of the conduit, at both the inlet and outlet ends of the conduit. Cable shall be free of sandy or gritty material during pulling. If cable is laid on ground during pulling, cable shall be wiped free of sandy or gritty material prior to entry of cable into conduit and prior to application of any pulling compound.

J. Properly coat wires and cables with pulling compound recommended by cable manufacturer before pulling into conduits and prevent mechanical damage to conductors during installation. Provide compounds that are not injurious to the cable and wire jackets and do not harden or become adhesive.

K. Other lubricants substituted must be accompanied by a statement from conductor manufacturer as to its acceptable use with conductors being installed.

L. Pull boxes located as indicated on the Drawings are based on nominal pulling tension and side-wall pressures. Install additional pull boxes as required to meet cable manufacturer's recommendations.

M. Tighten all screws and terminal bolts using torque type wrenches and/or drivers to tighten to the inch pound requirements of the NEC and UL.

N. Where single conductors and cables in manholes, handholes, vaults, and other indicated locations are not wrapped together by some other means such as arc and fireproofing tapes, bundle throughout their exposed length all conductors entering from each conduit with nylon, self locking, releasable, cable ties placed at intervals not exceeding 18 inches on centers.

O. Ends of cable shall not be exposed to environment more than 24 hours after pulling or splicing. After 24 hours the cable shall be purged with nitrogen or sealed with tape.

3.2 SPLICES AND TERMINATIONS

A. Cables shall be installed with a minimum of splices. Splice cables only as required to coordinate with the raceway system geometry, to meet manufacturers pulling tension requirements, and to conform to handhole and manhole pulling locations. Proposed splice locations shall be submitted to the Engineer for approval 2 weeks prior to commencement of the work.

B. The work area shall be kept warm, dry and ventilated during splicing and terminating of the cables. Under no conditions shall termination or splice work be performed when subjected to moisture. Tents shall be available at the project site to protect the splice area from rain. Pumps shall be available for keeping manholes or handholes dry during the splicing process. Blowers shall be provided to force fresh, dry air into manholes where free air circulation is obstructed. Unused duct shall be kept plugged and a temporary continuous curb or berm shall be provided to keep surface water away from the manhole or handhole during the cable work.

C. Prepare cables in accordance with splice or termination kit manufacturers installation details. Work on a particular splice or termination point shall be performed in one continuous work period until completed. Once an electrician has started a termination or splice, the work shall be completed by the same individual.

D. Maintain shield continuity around splices. Bond cable shields at each terminal or splice location. Shielded cables shall have the shields connected to ground test stations in manholes where splices occur. Where shielded cables have end points or terminations the shields shall be grounded to bus bars in enclosures.

E. Install a neoprene tape wrap around each splice and bonding jumper to provide a watertight environmental seal.

F. Terminations

1. Make terminations in stress cones. Carefully make up stress relief cones in accordance with cable manufacturer's instructions.

2. Install built up stress relief cones or provide separable connection fittings on all shield cable ends as shown on the Drawings. Insulate and seal each cable-to-bus termination with heat shrink cable bus connector kits.

3. Outdoor terminations: Use Class 1 factory preassembled kits and install in strict conformance with factory instructions.

4. Terminations within Equipment: Use Class 2 factory preassembled kits and install in strict conformance with factory instructions.

5. Insulate and seal each cable-to-bus termination with heat shrinkable bus connector kits.

3.3 ARC AND FIREPROOFING TAPES

A. Use arc and fireproofing tapes on all 22kV cables at all terminations, splices, manholes, handholes and junction boxes.

B. Wrap together as a single cable all conductors entering from each conduit. Wrap using one-half lapped layers of the tape.

C. Apply the tape in a single layer, one-half lapped or as recommended by the manufacture. Install the tape with the coated side towards the cable and extend it not less than 25mm (1 inch) into each duct. Secure the tape in place by a random wrap of glass cloth tape.

D. Follow tape manufacturer's installation instructions. Secure the arc and fireproofing tape at frequent intervals with bands of the specified glass cloth electrical tape. Make each band of at least two wraps of tape directly over each other.

3.4 ELECTRICAL IDENTIFICATION:

A. Position the cable identification tags so they will be easy to read after the fireproofing is installed.

B. Identify all circuits in accordance with the conductor identification system specified at switchgear, manholes, motor starters, primary substation transformers, terminations, etc.

3.5 FIELD QUALITY CONTROL

A. Field testing shall be performed as specified herein and per the requirement of Section 16080. The testing firm specified under 16080 shall provide all material, labor, equipment and technical supervision to perform the specified tests and inspections.

B. Equipment testing and inspection shall be performed in accordance with NETA Standard ATS and shall include the following:

1. Visual and mechanical inspection.

2. Shield continuity test.

3. Insulation resistance test.

4. DC HiPot test per IEEE Standard 400.

C. When new cables are spliced into existing cables, the DC high potential test shall be performed on each old and new cable prior to splicing. After test results are approved and the splice is completed, an insulation resistance test and a shield continuity test shall be performed on the length of new and existing cable including the splice. After a satisfactory insulation resistance test, a DC high potential test shall be performed on the cable utilizing a test voltage recommended by the testing firm and approved by the Engineer.

D. Submit certified copies of the test results and leakage plots to the Engineer within 5 days of completion of the tests.

E. Immediately notify the Engineer and do not energize the cables if any of the following conditions occur:

1. Cable damage.

2. Improper installation or grounding.

3. Shield discontinuity or high resistance.

4. Dielectric absorption ratio and polarization index below 1.5.

5. Abnormal plot of leakage current versus voltage.

F. Defective or Damaged Cables

1. The Engineer shall have sole determination of the acceptability of the cables based on the submitted test reports. Do not energize cables until the test reports have been reviewed and approved by the Engineer.

2. If in the opinion of the Engineer, the cables, terminations or splices are determined to be damaged or defective, provide the following remedial actions at no additional cost to the City:

a. Remove splices and terminations and completely re-test the cables to determine whether the cables are damaged or defective.

b. Remove and replace damaged or defective cables as directed by the Engineer.

c. Remake terminations and splices with new kits.

d. Completely re-test cable, splices and terminations as specified herein.

END OF SECTION

SECTION 16122 - FIBER OPTIC CABLES AND EQUIPMENT

PART 1 GENERAL

1.1 DESCRIPTION

A. This section covers includes furnishing, installing, and testing of the fiber optic communication equipment as shown on the Contract Documents.

B. The work of this Section includes providing and installing a fiber optic communications system including fiber optic cables, patch panels, splices, fiber optic transmitter and receiver, terminations, testing and implementation.

1.2 RELATED WORK

A. Section 13400 – Process Instrumentation and Controls – General Provisions

B. Section 13420 – Control Panels and Hardware

C. Section 16000 – General Electrical Provisions

1.3 SUBMITTALS

A. All submittals shall be in accordance with the Section 01300, and Section 16000.

B. Submit catalog data and characteristics of fiber optic system as specified in these Specifications including fiber, connectors, patch panels, converters, and other equipment.

1. Submit fiber optic cable descriptive product information and specifications including transmission parameters, jacket properties, and physical attributes (maximum short term and long term tensile loads).

2. Submit fiber optic system ancillary devices including terminations, patch panels, media converters, and other specified components. Submit descriptive product information and specifications including attenuation parameters, device characteristics, and physical attributes.

3. Submit fiber optic installation and pulling equipment methods proposed.

4. Submit the cable identification approach and scheme. The cable identification shall match the identification scheme as defined in the Contract Documents and per EIA/TIA 606.

5. Submit link-loss budget calculation for each end-to-end connection provided under this Contract. Incorporate requirements of any in-line attenuators, splicing, terminations, and fiber distances to accurately estimate the overall link-loss budget of each fiber segment. Submitted and favorably approved link-loss budget calculation shall be used for verification of field test results.

6. Submit fiber field acceptance and installation testing protocol including method of testing, proposed test equipment, and test result forms in conformance with the Specifications.

7. Submit completed fiber field testing forms and other results of field acceptance tests and installation tests.

1.4 QUALITY ASSURANCE AND QUALITY CONTROL

A. Products shall be manufactured by firms regularly engaged in manufacturing products described in this Section.

B. Field acceptance and installation tests shall be performed by qualified persons having five or more years of relevant fiber optic testing experience.

1.5 REFERENCES

A. Electronics Industry Association/Telecommunications Industry Association (EIA/TIA):

1. EIA/TIA 568B – Commercial Building Telecommunications Cabling Standard.

2. EIA/TIA 569A – Commercial Building Standard for Telecommunications Pathways and Spaces

3. EIA/TIA 598A – Optical Fiber Color Coding.

4. EIA/TIA TSB-72 – Centralized Optical Fiber Cabling Guidelines.

5. EIA/TIA 455 – Fiber Optic Test Procedures (FOTPs)

B. Insulated Cable Engineers Association (ICEA)

1. ANSI/ICEA-640 – Standard for Outside Fiber Outside Plant Communications Cable.

C. National Electrical Contractors Association (NECA)

1. NECA 301 – Standard for Installing and Testing Fiber Optic Cables

D. National Fire Protection Association (NFPA):

1. NFPA 70 – National Electrical Code (NEC).

PART 2 PRODUCTS

2.1 FIBER OPTIC CABLE

A. General Considerations and Cable Construction

1. The cable shall be loose tube design. The loose buffer tube shall be a water-blocking material. The water blocking material shall be non-nutritive to fungus, electrically non-conductive and homogenous. It shall also be free from dirt and foreign matter and shall be readily removable with conventional nontoxic solvents.

2. The cable shall be non-armored and stranded. The fibers shall not adhere to the inside of the buffer tube. The cable shall be gel-free design using water-swellable yarns and tapes for easier cable termination and splicing. Each fiber shall be distinguishable by means of color coding according per TIA/EIA-598-A, “Fiber-

Optic Color Code" Cable jackets shall be marked with manufacturers' name, sequential meter or foot markings, the year of manufacture, and a telecommunication handset symbol, as required by the National Electrical Safety Code (NESC). The actual length of the cable shall be within ±1 % of the length markings.

3. Buffer tubes shall be kink resistant within the specified minimum bend radius. The central anti-buckling member shall consist of a dielectric, glass reinforced plastic rod central member.

4. The cable shall be constructed with a protective coating surrounding the glass fiber.

5. Fiber optic cable installed indoors shall be UL listed and plenum rated for flame resistance. The cable shall contain only glass fiber with no metal element as listed per NEC Article 770 as type OFNP (nonconductive fiber plenum cable). Fiber cable installed in outdoor areas shall contain only glass fiber with no metal element as listed per NEC Article 770 as type OFN (nonconductive fiber general purpose cable). The fiber optic cables shall be factory tested in accordance with the procedures per EIA-445 Fiber Optic Test Procedures (FOTP).

6. The cable shall contain at least one ripcord under the sheath for easy sheath removal.

7. The cable shall have an overall aramid yarn strength member added to the buffered fibers to provide mechanical protection.

B. Fiber Optic Characteristics – MULTIMODE FIBER OPTIC CABLE

1. 50/125-micron, graded-index for use in backbone and horizontal distribution subsystems, meets or exceeds the requirements of TIA 568 C.3, including the following specifications:

2. Maximum Mean Fiber Loss:

   a. 3.5 dB per km at 850 nm.

   b. 1.5 dB per km at 1,300 nm.

3. Minimum OFL Bandwidth:

   a. OM2: 600m at 850nm and 600nm at 1310nm

   b. 500 MHz km minimum at 1,300nm

4. Distance Capacity per IEEE 802.3:

   a. 100 Mbit Ethernet OM2 300m at 850nm and 2000 m at 1310nm

   b. 1 Gbit Ethernet

5. OM2: 600m at 850nm and 600nm at 1310nm

   a. 10 Gbit Ethernet – 10km at 850 nm and 40km at 1310 nm:

6. OM2: 82m at 850 nm and 600 at 300 nm.

C. Type 50/250 OM2 Backbone for Underground Conduit and Building Riser Installation:

1. Individual Fibers: 50/125/250 microns.

2. Assembly:

a. Nonmetallic, gel-free, dry water blocked, loose-tube fiber core with dielectric strength member enclosed by nonmetallic cross-ply sheath; requires buffer tubing.

b. Cable: Comply with ICEA S 104 696.

3. NEC/UL Listing: OFNR

4. Protective Covering: Black, Flame and UV-resistant, thermoplastic jacket with rip-cord.

5. Minimum Short Term Pull Strength: 600 lbf.

6. Acceptable Manufacturers:

a. General Cable

b. Belden

c. Equal

D. Connectors

1. The fiber optic communications system shall utilize LC type connectors for fiber optic connections. The connectors shall be designed for use with multi-mode cables.

2. Multi-mode connectors shall be by Corning, General Cable, Belden, or Equal.

3. In cases where specified or required equipment is not available with LC type connectors, the contractor shall provide fiber optic jumpers that have LC type connectors on one end and the type of connector necessary to connect to the equipment provided on the other end.

2.2 FIBER PATCH PANELS

A. Provide patch panels for protection and termination of multimode fiber optic cables.

B. Rack mounted or panel (DIN-Rail) mounted as required.

C. Connectors for patch panels shall be included and be compatible with LC type fiber connectors. Number of fiber connectors as required by cable strand count.

D. Rack mounted patch panels shall incorporate top and bottom cable entry grommets for access and sealing of fiber cables, suitable for accommodating up to six 12-fiber connector panels

E. Panel mounted patch panels shall be suitable for installation on panel DIN rails per Sections 13400 and 13420, suitable for terminating up to 48 fiber strands.

F. Rack mounted patch panels: Acceptable manufactures: Corning CCH-03U, Anixter, Beldon or equal. Number of ports and multimode connections as required by the cable configuration shown on the Drawings and Fiber Allocation Table.

G. Panel, DIN rail mounted patch panels: Acceptable manufactures: DINSpace SNAP-XXLC, RLH Industries Slimline 2, Beldon MIPP, or equal. Number of ports and multimode connections as required by the cable configuration shown on the Drawings and Fiber Allocation Table.

2.3 FIBER OPTIC TO COPPER CONVERTER

A. Provide industrial grade media converter for conversion and connection of 10/100 Base to multi-mode fiber optics as shown on the Drawings. Unit shall be rated for temperatures from -10°C to +70°C and industrial levels of EMI/RFI emission and immunity conforming to FCC Class B rating.

B. Converter shall be suitable for panel mounting and include RJ-45 (TP) shielded port, full or half duplex, with auto-negotiation and auto MDI/MDI-X cross over functions. Fiber port (FX) shall support multi-mode LC fiber terminations with 100 Mbps full or half duplex and far end fault indication support. Unit fiber port shall conform to the fiber cable as specified in these Specifications.

C. Converter shall support IEEE 802.3x flow control with standard IEEE 802.3 Ethernet packet frames.

D. Provide converter with integral diagnostic LEDs. At a minimum, provide unit power status, TP port status, FX port status, activity, speed, duplex port status and optical link status.

E. Provide 120 Volt power supply.

F. Fiber Optic to copper converter Versitron MF727 series, Beldon, or equal.

PART 3 EXECUTION

3.1 FIBER OPTIC CABLE INSTALLATION

A. General

1. Install in conformance with NECA 301 – Standard for Installing and Testing Fiber Optic Cables.

2. Do not exceed cable manufacturer's recommendations for maximum pulling tensions and minimum bending radii. Where pulling compound is used, use only UL listed compound compatible with the cable outer jacket, voltage rating, and with the raceway involved.

3. Monitor pulling tensions while pulling and record the maximum tensions used. Advise the Engineer of cases exceeding the manufacturer's recommendations and remove and replace cables subjected to tensions in excess of those recommended.

4. Pulling of cable shall be performed in such a manner that the cable outer jacket does not scrape against the edge of the conduit, at both the inlet and outlet ends of the conduit. Cable shall be free of sandy or gritty material during pulling. Cable shall be wiped free of dirt, sand, or grit prior to entry of cable into conduit and prior to application of any pulling compound.

B. Installation

1. Swab out conduits prior to installing new cables. Inspect raceways and boxes for allowable bending radius prior to installing cable and notify the Engineer of any condition which would prevent the proper installation of the cable.

2. Lubricate cables with lubricants specially formulated for fiber cabling jackets during installation.

3. Pulleys used to install fiber optic cable must be sized according to the minimum bending radius.

4. Terminate all cabling per the cable and termination device manufacturer's instructions.

5. Provide Kellems or similar crimp-on grips for pulling the fiber optic cable. Use correct sized grip for the cable being pulled.

6. When laying loops of fiber on a surface during a pull, use "figure-8" loops to prevent twisting of cable.

C. Splicing

1. Install all new fibers on this Project without splicing unless specifically shown otherwise on the Drawings or required due to installation requirements.

2. Should specific installation requirements dictate a potential splice condition, immediately notify the Engineer regarding the specific requirements and need for a splice. Splicing shall not be allowed unless specifically approved by the Engineer.

3. All splices will be made via Fusion method of fiber interconnection.

4. Fibers to be spliced will be cleaned and cleaved at 90 degrees with precision, purpose specific splicing tools to minimize optical loss.

5. Fiber splices shall be made in areas where temperature, humidity, and cleanliness can be controlled. Provide a tent, trailer, etc. to ensure a controlled working environment.

6. Fusion splicing tools and equipment shall be kept in proper working condition and will be subject to regular maintenance according to the manufacturer's recommendations.

D. Splice Closure Installation

1. Locate splices and splice closures as shown on the plans or where required by the installation as approved by the Engineer.

2. Seal closure using tight, salt resistant procedure or as recommended by the manufacturer to provide a waterproof and age resistant splice closure.

3. Mount the splice closure to the side wall of the underground structure using stainless steel or nonmetallic hardware provided by the closure manufacturer.

4. Each splice shall be individually mounted and mechanically protected in the splice tray.

3.2 FIBER OPTIC CABLE SYSTEM FIELD TESTS

A. General

1. Field tests will be performed on each fiber. All fibers will be tested for breaks, abnormalities, and overall attenuation characteristics to ensure that the dB loss at each splice point and test location is in conformance with the requirements specified in these Specifications. Cables shall be tested per Standard NECA 301 where applicable and per the requirements of this Section.

2. Test jumpers (end-to-end attenuation) or test fiber box (OTDR) shall be the same fiber core size and connector type as the cable system.

3. Test each fiber with an optical power meter for end-to-end cable acceptance tests.

4. Test the multi-mode fiber at 850nm and 1300nm wavelengths using LED light sources.

5. For multi-mode, optical sources shall be stabilized and have center wavelengths within ± 20nm of the 1300nm multimode nominal wavelengths. In accordance with TIA/EIA-526-14-A, multimode LED sources shall have spectral widths from 30-60nm at 850nm and 100-140nm at 1300nm.

6. The power meter shall be calibrated at each of the nominal test wavelengths and traceable to the National Institute of Standards and Technology (NIST) calibration standard. The power meter and light source shall be set to the same wavelength.

7. All system connectors, jumpers, and adapters used during the test procedures shall be properly cleaned prior to and during test measurements.

8. Test technicians shall use the same brand and model of test equipment using the same testing profile for all tests performed under this Contract. Use of different test equipment and profiles shall result in test reports being rejected by the Engineer.

9. Install patch panels in wall or floor mounted communication racks as specified under Section 13422.

B. Pre-Installation Test

1. Perform OTDR on-the-reel test for each fiber strand in cable with fiber optic components after delivery to the project site. Test results shall be submitted for reviewed by the Engineer prior to cable installation.

2. Preparation: Assign a unique number to each reel. Record this reel number on the manufacturer's product test data shipped with the cable reel, and on each test report that references cable taken from the reel. Installed cable segments shall be traceable to the reel and thus the manufacturer's test data. If the manufacturer's product test data is not shipped with the cable reel, arrange for the cable distributor to provide a copy.

3. Performance Tests:

   a. Verify that each reel holds one continuous cable.

   b. Review factory-produced manufacturer's product test data to confirm conformance to the product specifications included in the Contract Documents.

   c. Furnish a copy of the OTDR test equipment calibration certificate.

   d. Verify cable length and attenuation is consistent with manufacturer's data sheet and reel identification.

   e. Test each multimode fiber optic strand for continuity and loss in the units of dB/km using a recording OTDR. Test each fiber at 850nm and 1300nm in one direction.

4. Test Report: Submit test reports for each reel of fiber optic cables. Reports shall include factory and field test results for each fiber.

   a. Test Summary Report: The test report shall include the following:

      1) Assigned reel identification number.

      2) Copy of the OTDR calibration certificate.

      3) Manufacturer's product test data.

      4) Cable identification as it appears on the OTDR printout.

      5) Cable identification as it appears according to the Contract Documents.

      6) Pass or fail status for each strand.

C. Installation Test

1. Perform installation test on each strand after cable has been installed and prior to the final acceptance test.

2. Cable shall be tested after the cable is pulled through conduits prior to splicing to verify that there has been no damage to cable after installation. The cable shall be tested with an OTDR and signature traces documented indicating the cable type, length and cable number per the Fiber Allocation Schedule included under Appendix 13465-A, as shown on the Drawings, or as directed by the Engineer.

3. An OTDR measurement shall be completed on each splice (if approved by the Engineer) and field installed connector. The measurement test shall be done after each splice and field connection to ensure that a clean, low-loss connection was made. Measurement shall be done in both directions.

4. Acceptable losses are as follows:

   a. Splices: ≤ 0.2 dB

   b. Field installed connectors: ≤ .75 dB.

5. If the measured splice or connector loss is unacceptable, the splice or connector shall be reworked and retested until the measured loss values are below the acceptable limits as specified.

6. Provide a Certificate of Compliance for Connector and Splice Loss. Document each splice and field connector measurement. Indicate cable number and location of splice and field connection.

D. Final Acceptance Test

1. Perform final acceptance test after satisfactory results on the installation test.

2. After installation of fiber cables are complete, perform an end-to-end attenuation test for each fiber cable link or from patch panel to patch panel as shown on the Drawings. Specified testing shall be performed in both directions of the installed cables using the specified wavelengths.

3. Use an OLTS power meter and source to test for attenuation losses.

4. Measured attenuation losses (dB) shall be documented for each fiber cable and compared to the link-loss budget.

5. If measured attenuation losses are greater than the maximum link-loss budget values, the fiber cable links in question will be required to have troubleshooting using an OTDR. The OTDR will be utilized to locate fault points in the cable system. Once the fault points are located and repaired the link shall be tested again with an OLTS to verify attenuation losses. This process shall be repeated until the attenuation losses are below the maximum link-loss budget for that particular fiber link.

6. Once the dual end-to-end attenuation test is completed the results shall be submitted in a test report for review and approval by the Engineer.

   a. Provide a brief explanation at the beginning of the report describing testing methods used.

   b. In the report include the budget link-loss for each link and indicate criteria used for dB loss values. Label each link using the conduit number as shown on the Drawings.

   c. Measured test values shall be provided in one section with the submitted and favorably reviewed budgeted link-loss values.

END OF SECTION

16122 – APPENDIX A

FIBER OPTIC ALLOCATION TABLE

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16122 APPENDIX A
FIBER ALLOCATION TABLE

CABLE	SUFFIX	STRAND	SOURCE				FUNCTION	DESTINATION				COMMENTS
			Fiber Optic Patch Panel No.	Patch Panel No.	Fiber Optic Patch Panel Location	TERMINATION POINT		Fiber Optic Patch Panel No.	Patch Panel No.	Fiber Optic Patch Panel Location	TERMINATION POINT	
FO27001	A	1	16-FO-02	1A	Screening/Grit Handling Building (16-CP-01)	TX	PLC Network 1	27-FO-01	1A	Blower Bldg Electrical Room (27-CP-01)	RX	
FO27001	A	2	16-FO-02	1A	Screening/Grit Handling Building (16-CP-01)	RX	PLC Network 1	27-FO-01	1A	Blower Bldg Electrical Room (27-CP-01)	TX	
FO27001	A	3	16-FO-02	1A	Screening/Grit Handling Building (16-CP-01)	TX	SCADA Network	27-FO-01	1A	Blower Bldg Electrical Room (27-CP-01)	RX	
FO27001	A	4	16-FO-02	1A	Screening/Grit Handling Building (16-CP-01)	RX	SCADA Network	27-FO-01	1A	Blower Bldg Electrical Room (27-CP-01)	TX	
FO27001	A	5	16-FO-02	1A	Screening/Grit Handling Building (16-CP-01)	TX	Business LAN	27-FO-01	1A	Blower Bldg Electrical Room (27-CP-01)	RX	
FO27001	A	6	16-FO-02	1A	Screening/Grit Handling Building (16-CP-01)	RX	Business LAN	27-FO-01	1A	Blower Bldg Electrical Room (27-CP-01)	TX	
FO27001	A	7	16-FO-02	1A	Screening/Grit Handling Building (16-CP-01)	TX	Security Access Network (Future)	27-FO-01	1A	Blower Bldg Electrical Room (27-CP-01)	RX	
FO27001	A	8	16-FO-02	1A	Screening/Grit Handling Building (16-CP-01)	RX	Security Access Network (Future)	27-FO-01	1A	Blower Bldg Electrical Room (27-CP-01)	TX	
FO27001	A	9	16-FO-02	1A	Screening/Grit Handling Building (16-CP-01)	TX	CCTV (Future)	27-FO-01	1A	Blower Bldg Electrical Room (27-CP-01)	RX	
FO27001	A	10	16-FO-02	1A	Screening/Grit Handling Building (16-CP-01)	RX	CCTV (Future)	27-FO-01	1A	Blower Bldg Electrical Room (27-CP-01)	TX	
FO27001	A	11	16-FO-02	1A	Screening/Grit Handling Building (16-CP-01)	TX	Protective Relay Network	27-FO-01	1A	Blower Bldg Electrical Room (27-CP-01)	RX	
FO27001	A	12	16-FO-02	1A	Screening/Grit Handling Building (16-CP-01)	RX	Protective Relay Network	27-FO-01	1A	Blower Bldg Electrical Room (27-CP-01)	TX	
FO27001	B	1	16-FO-02	1B	Screening/Grit Handling Building (16-CP-01)	TX	PLC Network 2	27-FO-01	1B	Blower Bldg Electrical Room (27-CP-01)	RX	
FO27001	B	2	16-FO-02	1B	Screening/Grit Handling Building (16-CP-01)	RX	PLC Network 2	27-FO-01	1B	Blower Bldg Electrical Room (27-CP-01)	TX	
FO27001	B	3	16-FO-02	1B	Screening/Grit Handling Building (16-CP-01)	TX	Equipment Monitoring Network	27-FO-01	1B	Blower Bldg Electrical Room (27-CP-01)	RX	
FO27001	B	4	16-FO-02	1B	Screening/Grit Handling Building (16-CP-01)	RX	Equipment Monitoring Network	27-FO-01	1B	Blower Bldg Electrical Room (27-CP-01)	TX	
FO27001	B	5	16-FO-02	1B	Screening/Grit Handling Building (16-CP-01)	TX	Power Monitoring Network	27-FO-01	1B	Blower Bldg Electrical Room (27-CP-01)	RX	
FO27001	B	6	16-FO-02	1B	Screening/Grit Handling Building (16-CP-01)	RX	Power Monitoring Network	27-FO-01	1B	Blower Bldg Electrical Room (27-CP-01)	TX	
FO27001	B	7	16-FO-02	1B	Screening/Grit Handling Building (16-CP-01)	TX	Spare	27-FO-01	1B	Blower Bldg Electrical Room (27-CP-01)	RX	
FO27001	B	8	16-FO-02	1B	Screening/Grit Handling Building (16-CP-01)	RX	Spare	27-FO-01	1B	Blower Bldg Electrical Room (27-CP-01)	TX	
FO27001	B	9	16-FO-02	1B	Screening/Grit Handling Building (16-CP-01)	TX	Spare	27-FO-01	1B	Blower Bldg Electrical Room (27-CP-01)	RX	
FO27001	B	10	16-FO-02	1B	Screening/Grit Handling Building (16-CP-01)	RX	Spare	27-FO-01	1B	Blower Bldg Electrical Room (27-CP-01)	TX	
FO27001	B	11	16-FO-02	1B	Screening/Grit Handling Building (16-CP-01)	TX	Spare	27-FO-01	1B	Blower Bldg Electrical Room (27-CP-01)	RX	
FO27001	B	12	16-FO-02	1B	Screening/Grit Handling Building (16-CP-01)	RX	Spare	27-FO-01	1B	Blower Bldg Electrical Room (27-CP-01)	TX	
FO27001	C	1	16-FO-02	1C	Screening/Grit Handling Building (16-CP-01)	TX	Spare	27-FO-01	1C	Blower Bldg Electrical Room (27-CP-01)	RX	
FO27001	C	2	16-FO-02	1C	Screening/Grit Handling Building (16-CP-01)	RX	Spare	27-FO-01	1C	Blower Bldg Electrical Room (27-CP-01)	TX	
FO27001	C	3	16-FO-02	1C	Screening/Grit Handling Building (16-CP-01)	TX	Spare	27-FO-01	1C	Blower Bldg Electrical Room (27-CP-01)	RX	
FO27001	C	4	16-FO-02	1C	Screening/Grit Handling Building (16-CP-01)	RX	Spare	27-FO-01	1C	Blower Bldg Electrical Room (27-CP-01)	TX	
FO27001	C	5	16-FO-02	1C	Screening/Grit Handling Building (16-CP-01)	TX	Spare	27-FO-01	1C	Blower Bldg Electrical Room (27-CP-01)	RX	

16122 APPENDIX A
FIBER ALLOCATION TABLE

CABLE	SUFFIX	STRAND	SOURCE				FUNCTION	DESTINATION				COMMENTS
			Fiber Optic Patch Panel No.	Patch Panel No.	Fiber Optic Patch Panel Location	TERMINATION POINT		Fiber Optic Patch Panel No.	Patch Panel No.	Fiber Optic Patch Panel Location	TERMINATION POINT	
FO27001	C	6	16-FO-02	1C	Screening/Grit Handling Building (16-CP-01)	RX	Spare	27-FO-01	1C	Blower Bldg Electrical Room (27-CP-01)	TX	
FO27001	C	7	16-FO-02	1C	Screening/Grit Handling Building (16-CP-01)	TX	Spare	27-FO-01	1C	Blower Bldg Electrical Room (27-CP-01)	RX	
FO27001	C	8	16-FO-02	1C	Screening/Grit Handling Building (16-CP-01)	RX	Spare	27-FO-01	1C	Blower Bldg Electrical Room (27-CP-01)	TX	
FO27001	C	9	16-FO-02	1C	Screening/Grit Handling Building (16-CP-01)	TX	Spare	27-FO-01	1C	Blower Bldg Electrical Room (27-CP-01)	RX	
FO27001	C	10	16-FO-02	1C	Screening/Grit Handling Building (16-CP-01)	RX	Spare	27-FO-01	1C	Blower Bldg Electrical Room (27-CP-01)	TX	
FO27001	C	11	16-FO-02	1C	Screening/Grit Handling Building (16-CP-01)	TX	Spare	27-FO-01	1C	Blower Bldg Electrical Room (27-CP-01)	RX	
FO27001	C	12	16-FO-02	1C	Screening/Grit Handling Building (16-CP-01)	RX	Spare	27-FO-01	1C	Blower Bldg Electrical Room (27-CP-01)	TX	
FO80001	A	1	52-FO-01	1A	Biosolids Dryer Bldg (52-CP-01)	TX	PLC Network 1	80-FO-01	2A	Administration Bldg (80-CP-01)	RX	Note 5
FO80001	A	2	52-FO-01	1A	Biosolids Dryer Bldg (52-CP-01)	RX	PLC Network 1	80-FO-01	2A	Administration Bldg (80-CP-01)	TX	Note 5
FO80001	A	3	52-FO-01	1A	Biosolids Dryer Bldg (52-CP-01)	TX	SCADA Network	80-FO-01	2A	Administration Bldg (80-CP-01)	RX	Note 5
FO80001	A	4	52-FO-01	1A	Biosolids Dryer Bldg (52-CP-01)	RX	SCADA Network	80-FO-01	2A	Administration Bldg (80-CP-01)	TX	Note 5
FO80001	A	5	52-FO-01	1A	Biosolids Dryer Bldg (52-CP-01)	TX	Business LAN	80-FO-01	2A	Administration Bldg (80-CP-01)	RX	Note 5
FO80001	A	6	52-FO-01	1A	Biosolids Dryer Bldg (52-CP-01)	RX	Business LAN	80-FO-01	2A	Administration Bldg (80-CP-01)	TX	Note 5
FO80001	A	7	52-FO-01	1A	Biosolids Dryer Bldg (52-CP-01)	TX	Security Access Network (Future)	80-FO-01	2A	Administration Bldg (80-CP-01)	RX	Note 5
FO80001	A	8	52-FO-01	1A	Biosolids Dryer Bldg (52-CP-01)	RX	Security Access Network (Future)	80-FO-01	2A	Administration Bldg (80-CP-01)	TX	Note 5
FO80001	A	9	52-FO-01	1A	Biosolids Dryer Bldg (52-CP-01)	TX	CCTV (Future)	80-FO-01	2A	Administration Bldg (80-CP-01)	RX	Note 5
FO80001	A	10	52-FO-01	1A	Biosolids Dryer Bldg (52-CP-01)	RX	CCTV (Future)	80-FO-01	2A	Administration Bldg (80-CP-01)	TX	Note 5
FO80001	A	11	52-FO-01	1A	Biosolids Dryer Bldg (52-CP-01)	TX	Protective Relay Network (Future)	80-FO-01	2A	Administration Bldg (80-CP-01)	RX	Provision for IEC 61850 network. Note 5
FO80001	A	12	52-FO-01	1A	Biosolids Dryer Bldg (52-CP-01)	RX	Protective Relay Network (Future)	80-FO-01	2A	Administration Bldg (80-CP-01)	TX	Provision for IEC 61850 network. Note 5
FO80001	B	1	52-FO-01	1B	Biosolids Dryer Bldg (52-CP-01)	TX	PLC Network 2	80-FO-01	2B	Administration Bldg (80-CP-01)	RX	Note 5
FO80001	B	2	52-FO-01	1B	Biosolids Dryer Bldg (52-CP-01)	RX	PLC Network 2	80-FO-01	2B	Administration Bldg (80-CP-01)	TX	Note 5
FO80001	B	3	52-FO-01	1B	Biosolids Dryer Bldg (52-CP-01)	TX	Equipment Monitoring Network	80-FO-01	2B	Administration Bldg (80-CP-01)	RX	Note 5
FO80001	B	4	52-FO-01	1B	Biosolids Dryer Bldg (52-CP-01)	RX	Equipment Monitoring Network	80-FO-01	2B	Administration Bldg (80-CP-01)	TX	Note 5
FO80001	B	5	52-FO-01	1B	Biosolids Dryer Bldg (52-CP-01)	TX	Power Monitoring Network	80-FO-01	2B	Administration Bldg (80-CP-01)	RX	Note 5
FO80001	B	6	52-FO-01	1B	Biosolids Dryer Bldg (52-CP-01)	RX	Power Monitoring Network	80-FO-01	2B	Administration Bldg (80-CP-01)	TX	Note 5
FO80001	B	7	52-FO-01	1B	Biosolids Dryer Bldg (52-CP-01)	TX	Spare	80-FO-01	2B	Administration Bldg (80-CP-01)	RX	Note 5
FO80001	B	8	52-FO-01	1B	Biosolids Dryer Bldg (52-CP-01)	RX	Spare	80-FO-01	2B	Administration Bldg (80-CP-01)	TX	Note 5
FO80001	B	9	52-FO-01	1B	Biosolids Dryer Bldg (52-CP-01)	TX	Spare	80-FO-01	2B	Administration Bldg (80-CP-01)	RX	Note 5
FO80001	B	10	52-FO-01	1B	Biosolids Dryer Bldg (52-CP-01)	RX	Spare	80-FO-01	2B	Administration Bldg (80-CP-01)	TX	Note 5

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FIBER ALLOCATION TABLE

CABLE	SUFFIX	STRAND	SOURCE				FUNCTION	DESTINATION				COMMENTS
			Fiber Optic Patch Panel No.	Patch Panel No.	Fiber Optic Patch Panel Location	TERMINATION POINT		Fiber Optic Patch Panel No.	Patch Panel No.	Fiber Optic Patch Panel Location	TERMINATION POINT	
FO80001	B	11	52-FO-01	1B	Biosolids Dryer Bldg (52-CP-01)	TX	Spare	80-FO-01	2B	Administration Bldg (80-CP-01)	RX	Note 5
FO80001	B	12	52-FO-01	1B	Biosolids Dryer Bldg (52-CP-01)	RX	Spare	80-FO-01	2B	Administration Bldg (80-CP-01)	TX	Note 5
FO80001	C	1	52-FO-01	1C	Biosolids Dryer Bldg (52-CP-01)	TX	Door Access/Security (Future)	80-FO-01	2C	Administration Bldg (80-CP-01)	RX	Note 5
FO80001	C	2	52-FO-01	1C	Biosolids Dryer Bldg (52-CP-01)	RX	Door Access/Security (Future)	80-FO-01	2C	Administration Bldg (80-CP-01)	TX	Note 5
FO80001	C	3	52-FO-01	1C	Biosolids Dryer Bldg (52-CP-01)	TX	CCTV (Future)	80-FO-01	2C	Administration Bldg (80-CP-01)	RX	Note 5
FO80001	C	4	52-FO-01	1C	Biosolids Dryer Bldg (52-CP-01)	RX	CCTV (Future)	80-FO-01	2C	Administration Bldg (80-CP-01)	TX	Note 5
FO80001	C	5	52-FO-01	1C	Biosolids Dryer Bldg (52-CP-01)	TX	Spare	80-FO-01	2C	Administration Bldg (80-CP-01)	RX	Note 5
FO80001	C	6	52-FO-01	1C	Biosolids Dryer Bldg (52-CP-01)	RX	Spare	80-FO-01	2C	Administration Bldg (80-CP-01)	TX	Note 5
FO80001	C	7	52-FO-01	1C	Biosolids Dryer Bldg (52-CP-01)	TX	Spare	80-FO-01	2C	Administration Bldg (80-CP-01)	RX	Note 5
FO80001	C	8	52-FO-01	1C	Biosolids Dryer Bldg (52-CP-01)	RX	Spare	80-FO-01	2C	Administration Bldg (80-CP-01)	TX	Note 5
FO80001	C	9	52-FO-01	1C	Biosolids Dryer Bldg (52-CP-01)	TX	Spare	80-FO-01	2C	Administration Bldg (80-CP-01)	RX	Note 5
FO80001	C	10	52-FO-01	1C	Biosolids Dryer Bldg (52-CP-01)	RX	Spare	80-FO-01	2C	Administration Bldg (80-CP-01)	TX	Note 5
FO80001	C	11	52-FO-01	1C	Biosolids Dryer Bldg (52-CP-01)	TX	Spare	80-FO-01	2C	Administration Bldg (80-CP-01)	RX	Note 5
FO80001	C	12	52-FO-01	1C	Biosolids Dryer Bldg (52-CP-01)	RX	Spare	80-FO-01	2C	Administration Bldg (80-CP-01)	TX	Note 5
FO15001	A	1	16-FO-02	3A	Screening/Grit Handling Bldg (16-CP-01)	TX	Switchgear Monitoring Network	SWGR-DA	1A	MV Electrical Facility (SWGR-DA)	RX	
FO15001	A	2	16-FO-02	3A	Screening/Grit Handling Bldg (16-CP-01)	RX	Switchgear Monitoring Network	SWGR-DA	1A	MV Electrical Facility (SWGR-DA)	TX	
FO15001	A	3	16-FO-02	3A	Screening/Grit Handling Bldg (16-CP-01)	TX	Protective Relay Network (Future)	SWGR-DA	1A	MV Electrical Facility (SWGR-DA)	RX	
FO15001	A	4	16-FO-02	3A	Screening/Grit Handling Bldg (16-CP-01)	RX	Protective Relay Network (Future)	SWGR-DA	1A	MV Electrical Facility (SWGR-DA)	TX	
FO15001	A	5	16-FO-02	3A	Screening/Grit Handling Bldg (16-CP-01)	TX	Power Monitoring Network	SWGR-DA	1A	MV Electrical Facility (SWGR-DA)	RX	
FO15001	A	6	16-FO-02	3A	Screening/Grit Handling Bldg (16-CP-01)	RX	Power Monitoring Network	SWGR-DA	1A	MV Electrical Facility (SWGR-DA)	TX	
FO15001	A	7	16-FO-02	3A	Screening/Grit Handling Bldg (16-CP-01)	TX	Spare	SWGR-DA	1A	MV Electrical Facility (SWGR-DA)	RX	
FO15001	A	8	16-FO-02	3A	Screening/Grit Handling Bldg (16-CP-01)	RX	Spare	SWGR-DA	1A	MV Electrical Facility (SWGR-DA)	TX	
FO15001	A	9	16-FO-02	3A	Screening/Grit Handling Bldg (16-CP-01)	TX	Spare	SWGR-DA	1A	MV Electrical Facility (SWGR-DA)	RX	
FO15001	A	10	16-FO-02	3A	Screening/Grit Handling Bldg (16-CP-01)	RX	Spare	SWGR-DA	1A	MV Electrical Facility (SWGR-DA)	TX	
FO15001	A	11	16-FO-02	3A	Screening/Grit Handling Bldg (16-CP-01)	TX	Spare	SWGR-DA	1A	MV Electrical Facility (SWGR-DA)	RX	
FO15001	A	12	16-FO-02	3A	Screening/Grit Handling Bldg (16-CP-01)	RX	Spare	SWGR-DA	1A	MV Electrical Facility (SWGR-DA)	TX	
FO15002	A	1	16-FO-02	3B	Screening/Grit Handling Bldg (16-CP-01)	TX	Switchgear Monitoring Network	SWGR-DB	1A	MV Electrical Facility (SWGR-DB)	RX	
FO15002	A	2	16-FO-02	3B	Screening/Grit Handling Bldg (16-CP-01)	RX	Switchgear Monitoring Network	SWGR-DB	1A	MV Electrical Facility (SWGR-DB)	TX	
FO15002	A	3	16-FO-02	3B	Screening/Grit Handling Bldg (16-CP-01)	TX	Protective Relay Network (Future)	SWGR-DB	1A	MV Electrical Facility (SWGR-DB)	RX	Provision for IEC 61850 network

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FIBER ALLOCATION TABLE

CABLE	SUFFIX	STRAND	SOURCE				FUNCTION	DESTINATION				COMMENTS
			Fiber Optic Patch Panel No.	Patch Panel No.	Fiber Optic Patch Panel Location	TERMINATION POINT		Fiber Optic Patch Panel No.	Patch Panel No.	Fiber Optic Patch Panel Location	TERMINATION POINT	
FO15002	A	4	16-FO-02	3B	Screening/Grit Handling Bldg (16-CP-01)	RX	Protective Relay Network (Future)	SWGR-DB	1A	MV Electrical Facility (SWGR-DB)	TX	Provision for IEC 61850 network
FO15002	A	5	16-FO-02	3B	Screening/Grit Handling Bldg (16-CP-01)	TX	Door Access/Security (Future)	SWGR-DB	1A	MV Electrical Facility (SWGR-DB)	RX	
FO15002	A	6	16-FO-02	3B	Screening/Grit Handling Bldg (16-CP-01)	RX	Door Access/Security (Future)	SWGR-DB	1A	MV Electrical Facility (SWGR-DB)	TX	
FO15002	A	7	16-FO-02	3B	Screening/Grit Handling Bldg (16-CP-01)	TX	CCTV (Future)	SWGR-DB	1A	MV Electrical Facility (SWGR-DB)	RX	
FO15002	A	8	16-FO-02	3B	Screening/Grit Handling Bldg (16-CP-01)	RX	CCTV (Future)	SWGR-DB	1A	MV Electrical Facility (SWGR-DB)	TX	
FO15002	A	9	16-FO-02	3B	Screening/Grit Handling Bldg (16-CP-01)	TX	Spare	SWGR-DB	1A	MV Electrical Facility (SWGR-DB)	RX	
FO15002	A	10	16-FO-02	3B	Screening/Grit Handling Bldg (16-CP-01)	RX	Spare	SWGR-DB	1A	MV Electrical Facility (SWGR-DB)	TX	
FO15002	A	11	16-FO-02	3B	Screening/Grit Handling Bldg (16-CP-01)	TX	Spare	SWGR-DB	1A	MV Electrical Facility (SWGR-DB)	RX	
FO15002	A	12	16-FO-02	3B	Screening/Grit Handling Bldg (16-CP-01)	RX	Spare	SWGR-DB	1A	MV Electrical Facility (SWGR-DB)	TX	
FO15003	A	1	16-FO-02	3C	Screening/Grit Handling Bldg (16-CP-01)	TX	Equipment Monitoring Network	MVSG1	1A	MV Electrical Facility (MVSG1)	RX	
FO15003	A	2	16-FO-02	3C	Screening/Grit Handling Bldg (16-CP-01)	RX	Equipment Monitoring Network	MVSG1	1A	MV Electrical Facility (MVSG1)	TX	
FO15003	A	3	16-FO-02	3C	Screening/Grit Handling Bldg (16-CP-01)	TX	Protective Relay Network (Future)	MVSG1	1A	MV Electrical Facility (MVSG1)	RX	Provision for IEC 61850 network
FO15003	A	4	16-FO-02	3C	Screening/Grit Handling Bldg (16-CP-01)	RX	Protective Relay Network (Future)	MVSG1	1A	MV Electrical Facility (MVSG1)	TX	Provision for IEC 61850 network
FO15003	A	5	16-FO-02	3C	Screening/Grit Handling Bldg (16-CP-01)	TX	Power Monitoring Network	MVSG1	1A	MV Electrical Facility (MVSG1)	RX	
FO15003	A	6	16-FO-02	3C	Screening/Grit Handling Bldg (16-CP-01)	RX	Power Monitoring Network	MVSG1	1A	MV Electrical Facility (MVSG1)	TX	
FO15003	A	7	16-FO-02	3C	Screening/Grit Handling Bldg (16-CP-01)	TX	Spare	MVSG1	1A	MV Electrical Facility (MVSG1)	RX	
FO15003	A	8	16-FO-02	3C	Screening/Grit Handling Bldg (16-CP-01)	RX	Spare	MVSG1	1A	MV Electrical Facility (MVSG1)	TX	
FO15003	A	9	16-FO-02	3C	Screening/Grit Handling Bldg (16-CP-01)	TX	Spare	MVSG1	1A	MV Electrical Facility (MVSG1)	RX	
FO15003	A	10	16-FO-02	3C	Screening/Grit Handling Bldg (16-CP-01)	RX	Spare	MVSG1	1A	MV Electrical Facility (MVSG1)	TX	
FO15003	A	11	16-FO-02	3C	Screening/Grit Handling Bldg (16-CP-01)	TX	Spare	MVSG1	1A	MV Electrical Facility (MVSG1)	RX	
FO15003	A	12	16-FO-02	3C	Screening/Grit Handling Bldg (16-CP-01)	RX	Spare	MVSG1	1A	MV Electrical Facility (MVSG1)	TX	
FO15004	A	1	16-FO-02	3D	Screening/Grit Handling Bldg (16-CP-01)	TX	Equipment Monitoring Network	GEN-2	1A	MV Electrical Facility (GEN-2)	RX	
FO15004	A	2	16-FO-02	3D	Screening/Grit Handling Bldg (16-CP-01)	RX	Equipment Monitoring Network	GEN-2	1A	MV Electrical Facility (GEN-2)	TX	
FO15004	A	3	16-FO-02	3D	Screening/Grit Handling Bldg (16-CP-01)	TX	Protective Relay Network (Future)	GEN-2	1A	MV Electrical Facility (GEN-2)	RX	Provision for IEC 61850 network
FO15004	A	4	16-FO-02	3D	Screening/Grit Handling Bldg (16-CP-01)	RX	Protective Relay Network (Future)	GEN-2	1A	MV Electrical Facility (GEN-2)	TX	Provision for IEC 61850 network
FO15004	A	5	16-FO-02	3D	Screening/Grit Handling Bldg (16-CP-01)	TX	Door Access/Security (Future)	GEN-2	1A	MV Electrical Facility (GEN-2)	RX	
FO15004	A	6	16-FO-02	3D	Screening/Grit Handling Bldg (16-CP-01)	RX	Door Access/Security (Future)	GEN-2	1A	MV Electrical Facility (GEN-2)	TX	
FO15004	A	7	16-FO-02	3D	Screening/Grit Handling Bldg (16-CP-01)	TX	CCTV (Future)	GEN-2	1A	MV Electrical Facility (GEN-2)	RX	
FO15004	A	8	16-FO-02	3D	Screening/Grit Handling Bldg (16-CP-01)	RX	CCTV (Future)	GEN-2	1A	MV Electrical Facility (GEN-2)	TX	

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FIBER ALLOCATION TABLE

CABLE	SUFFIX	STRAND	SOURCE				FUNCTION	DESTINATION				COMMENTS
			Fiber Optic Patch Panel No.	Patch Panel No.	Fiber Optic Patch Panel Location	TERMINATION POINT		Fiber Optic Patch Panel No.	Patch Panel No.	Fiber Optic Patch Panel Location	TERMINATION POINT	
FO15004	A	9	16-FO-02	3D	Screening/Grit Handling Bldg (16-CP-01)	TX	Spare	GEN-2	1A	MV Electrical Facility (GEN-2)	RX	
FO15004	A	10	16-FO-02	3D	Screening/Grit Handling Bldg (16-CP-01)	RX	Spare	GEN-2	1A	MV Electrical Facility (GEN-2)	TX	
FO15004	A	11	16-FO-02	3D	Screening/Grit Handling Bldg (16-CP-01)	TX	Spare	GEN-2	1A	MV Electrical Facility (GEN-2)	RX	
FO15004	A	12	16-FO-02	3D	Screening/Grit Handling Bldg (16-CP-01)	RX	Spare	GEN-2	1A	MV Electrical Facility (GEN-2)	TX	
FO34001	A	1	27-FO-02	1A	Blower Bldg Electrical Room (27-CP-01)	TX	PLC Remote I/O	34-CP-01	1A	MCC D3 (34-CP-01)	RX	
FO34001	A	2	27-FO-02	1A	Blower Bldg Electrical Room (27-CP-01)	RX	PLC Remote I/O	34-CP-01	1A	MCC D3 (34-CP-01)	TX	
FO34001	A	3	27-FO-02	1A	Blower Bldg Electrical Room (27-CP-01)	TX	Equipment Monitoring Network	34-CP-01	1A	MCC D3 (34-CP-01)	RX	
FO34001	A	4	27-FO-02	1A	Blower Bldg Electrical Room (27-CP-01)	RX	Equipment Monitoring Network	34-CP-01	1A	MCC D3 (34-CP-01)	TX	
FO34001	A	5	27-FO-02	1A	Blower Bldg Electrical Room (27-CP-01)	TX	Door Access/Security (Future)	34-CP-01	1A	MCC D3 (34-CP-01)	RX	
FO34001	A	6	27-FO-02	1A	Blower Bldg Electrical Room (27-CP-01)	RX	Door Access/Security (Future)	34-CP-01	1A	MCC D3 (34-CP-01)	TX	
FO34001	A	7	27-FO-02	1A	Blower Bldg Electrical Room (27-CP-01)	TX	CCTV (Future)	34-CP-01	1A	MCC D3 (34-CP-01)	RX	
FO34001	A	8	27-FO-02	1A	Blower Bldg Electrical Room (27-CP-01)	RX	CCTV (Future)	34-CP-01	1A	MCC D3 (34-CP-01)	TX	
FO34001	A	9	27-FO-02	1A	Blower Bldg Electrical Room (27-CP-01)	TX	Power Monitoring Network	34-CP-01	1A	MCC D3 (34-CP-01)	RX	
FO34001	A	10	27-FO-02	1A	Blower Bldg Electrical Room (27-CP-01)	RX	Power Monitoring Network	34-CP-01	1A	MCC D3 (34-CP-01)	TX	
FO34001	A	11	27-FO-02	1A	Blower Bldg Electrical Room (27-CP-01)	TX	Spare	34-CP-01	1A	MCC D3 (34-CP-01)	RX	
FO34001	A	12	27-FO-02	1A	Blower Bldg Electrical Room (27-CP-01)	RX	Spare	34-CP-01	1A	MCC D3 (34-CP-01)	TX	
FO51001	A	1	27-FO-02	1B	Blower Bldg Electrical Room (27-CP-01)	TX	PLC Remote I/O	51-CP-01	1A	WAS Storage (51-CP-01)	RX	
FO51001	A	2	27-FO-02	1B	Blower Bldg Electrical Room (27-CP-01)	RX	PLC Remote I/O	51-CP-01	1A	WAS Storage (51-CP-01)	TX	
FO51001	A	3	27-FO-02	1B	Blower Bldg Electrical Room (27-CP-01)	TX	Equipment Monitoring Network	51-CP-01	1A	WAS Storage (51-CP-01)	RX	
FO51001	A	4	27-FO-02	1B	Blower Bldg Electrical Room (27-CP-01)	RX	Equipment Monitoring Network	51-CP-01	1A	WAS Storage (51-CP-01)	TX	
FO51001	A	5	27-FO-02	1B	Blower Bldg Electrical Room (27-CP-01)	TX	Door Access/Security (Future)	51-CP-01	1A	WAS Storage (51-CP-01)	RX	
FO51001	A	6	27-FO-02	1B	Blower Bldg Electrical Room (27-CP-01)	RX	Door Access/Security (Future)	51-CP-01	1A	WAS Storage (51-CP-01)	TX	
FO51001	A	7	27-FO-02	1B	Blower Bldg Electrical Room (27-CP-01)	TX	CCTV (Future)	51-CP-01	1A	WAS Storage (51-CP-01)	RX	
FO51001	A	8	27-FO-02	1B	Blower Bldg Electrical Room (27-CP-01)	RX	CCTV (Future)	51-CP-01	1A	WAS Storage (51-CP-01)	TX	
FO51001	A	9	27-FO-02	1B	Blower Bldg Electrical Room (27-CP-01)	TX	Power Monitoring Network	51-CP-01	1A	WAS Storage (51-CP-01)	RX	
FO51001	A	10	27-FO-02	1B	Blower Bldg Electrical Room (27-CP-01)	RX	Power Monitoring Network	51-CP-01	1A	WAS Storage (51-CP-01)	TX	
FO51001	A	11	27-FO-02	1B	Blower Bldg Electrical Room (27-CP-01)	TX	Spare	51-CP-01	1A	WAS Storage (51-CP-01)	RX	
FO51001	A	12	27-FO-02	1B	Blower Bldg Electrical Room (27-CP-01)	RX	Spare	51-CP-01	1A	WAS Storage (51-CP-01)	TX	

NOTES TO FIBER ALLOCATION TABLE:

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FIBER ALLOCATION TABLE

CABLE	SUFFIX	STRAND	SOURCE				FUNCTION	DESTINATION				COMMENTS
			Fiber Optic Patch Panel No.	Patch Panel No.	Fiber Optic Patch Panel Location	TERMINATION POINT		Fiber Optic Patch Panel No.	Patch Panel No.	Fiber Optic Patch Panel Location	TERMINATION POINT	

1. Fiber allocation table is provided for reference only. Contractor to determine final network requirements as determined by installed equipment.
2. Provide suitable patch cords as required for terminating each fiber at the patch panel termination points.
3. Existing fiber optic connections not shown. Refer to Reference Drawings Aurora Project #2017 O&M Manual Volume 8 - Drawings.
4. Provide multimode fibers for all cables installed on this Project
5. Work is included as part of Schedules C, D and E and shall not be performed if those Schedules are not selected. Refer to Specification Section 01025 – Measurement and Payment for additional detail on Bid Schedul

SECTION 16130 – RACEWAY AND BOXES

PART 1 GENERAL

1.1 DESCRIPTION

A. Work included:

1. This section covers the work necessary to furnish and install, complete raceways and boxes for electrical systems.

2. Raceway Schedules indicating conductor number and minimum required conductor sizes are included in Appendix 16130-A. The Schedules are prepared as a guide to the Contractor and additional circuits from home runs, specialty manufacturers cables, and supplier specific wiring may require additional conductors not specifically included in the schedule. Such items not included in the Schedules shall not relieve the Contractor of the responsibility of furnishing and installing the necessary cables and raceways as required by the remainder of the Contract Documents for a fully functioning and operational system.

3. Home runs indicated are to assist the Contractor in identifying raceways to be installed concealed or exposed. Raceways identified to be installed exposed on the Drawings shall be run near the ceilings or along the walls of the areas through which they pass and shall be routed to avoid conflicts with HVAC ducts, cranes and hoists, lighting fixtures, doors and hatches. Raceways indicated to be run concealed shall be run in the center of concrete floor slabs, in partitions, or above hung ceilings, as required.

4. Raceway supports and restraints indicated on the Drawings are shown only to convey the general intent of the design and not intended to represent a complete system for all locations. The absence of location and specific details of the supports, additional restraints, and other mounting details on the Drawings shall not relieve the Contractor of the responsibility for providing them as specified. Raceway support layouts, supporting calculations, and required hardware for the raceway system are included in the Contractor's Scope of Work.

1.2 RELATED SECTIONS:

A. Conduit Schedules are included under Appendix 16130-A

B. Section 16000 – Common Work Results For Electrical

C. Section 16075 – Identification of Electrical Systems

D. Section 16600 – Underground Ducts and Raceways for Electrical Systems

1.3 SUBMITTALS

A. Submit data in accordance with Section 01340 and Section 16000.

B. Submit manufacturers' names, product designation, and catalog numbers with marked cut sheets clearly and uniquely identifying all materials to be provided under this

Section. Submit data for conduits, raceways, fittings, boxes, hardware, identification systems, and other materials specified in this Section.

C. Submit specific details and methodology for water sealing around conduits entering structures below grade. Submittal shall include plan showing locations of entries, method of entry (core drill, block out, etc.), method for sealing against entry of water into the building or structure, and sealing materials or devices.

D. Submit sealing schedule for conduit sealing procedures for hazardous locations as specified herein.

1.4 REFERENCES

A. American National Standards Institute (ANSI)

1. ANSI C80.1: Electrical Rigid Steel Conduit (ERSC).

2. ANSI C80.3: Steel Electrical Metallic Tubing

3. ANSI C80.4: Fittings for Rigid Metal Conduit and Electrical Metal Tubing.

B. California Code of Regulations

1. Title 24, Part 3 – 2016 California Electrical Code (NEC)

C. National Electrical Manufacturer's Associate (NEMA)

1. NEMA FB 1: Fittings, Cast Metal Boxes, and Conduit Bodies for Conduit, Electrical Metallic Tubing, and Cable

2. NEMA RN 1: Polyvinyl-Chloride (PVC) Externally Coated Galvanized Rigid Steel Conduit and Intermediate Metal Conduit

3. NEMA TC2: Electrical Polyvinyl Chloride (PVC) Conduit

4. NEMA TC3: Polyvinyl Chloride (PVC) Fittings for Use with Rigid PVC Conduit and Tubing

D. Federal Specifications (FS)

1. FS W-C-586D (A-A-50563): Conduit Outlet Boxes, Bodies, and Entrance Caps, Electrical: Cast Metal

2. FS W-C-1094: Conduit and Conduit Fittings Plastic, Rigid

E. Underwriters Laboratory (UL)

1. UL 6: Electrical Rigid Metal Conduit - Steel

2. UL 514B: Fittings for Conduit and Outlet Bodies

3. UL 651A: Type EB and A Rigid PVC Conduit and HDPE Conduit

4. UL 797: Electrical Metallic Tubing - Steel

5. UL 1242: Electrical Intermediate Metal Conduit – Steel

6. UL 1660: Liquid-Tight Flexible Non-Metallic Conduit

1.5 CONDUIT SCHEDULES

A. General: Conduit schedules are included in Appendix 16130-A.

B. Identification: Conduits are identified on the Drawings using a tagging scheme as follows:

XXYY###A

where

XX: one or two letter designating function per the table below

YY: 2-digit area number

###: conduit number selected to ensure uniqueness

A: for parallel power feeder conduits, merged control conduits, parallel fiber optic conduits, or otherwise as required to ensure uniqueness

C. Functional Designation Table

Conduit Designator Table

Letter Designator	Function
B	DC Battery
C	Control and Monitoring 120V
CM	Control and Monitoring 120V, Multiconductor Cable
EL	UPS 120V Circuit - UPS Sourced
EP	UPS 480V Circuit - UPS Sourced
FA	Fire Alarm
FO	Fiber Optic
J	Control, Low Voltage DC Discrete
L	240/208/120V Panelboard Circuit
M	Power, Medium Voltage
N	Other Network or Data Link
P	Power, <=480V
S	Low Voltage Signal (4-20mA)
T	Telephone/Communications
U	Utility Service Conduits
X	Spare (e.g., PX#### = spare power conduit)

1.6 QUALITY ASSURANCE

A. The Contractor shall require that all persons engaged in the installation of PVC coated rigid steel conduit, elbows, nipples, and fittings attend installation training classes given by the approved manufacturer at the job site before any conduit installation work begins. The Engineer shall take part in the installation training classes. The classes shall be carried out by technically competent and experienced instructors who are certified manufacturer's employees and instructors acceptable to the Engineer. The Contractor shall notify the Engineer two weeks in advance of the scheduled classes.

B. The Contractor shall demonstrate to the Engineer that the approved manufacturer's recommended installation tools and methods are being utilized on the job site by all persons engaged in the installation of PVC coated rigid steel conduit, elbows, nipples, and fittings. These tools and methods shall include, but not be limited to, clamp inserts for use on power driven units of chain vises, new die heads and enlarged pipe guides in conduit threading machines, and strap wrenches and extra wide wrench jaws for use in conduit assembly.

PART 2 PRODUCTS

2.1 STEEL CONDUIT AND FITTINGS

A. Galvanized Rigid Steel Conduit (GRS)

1. Hot-dipped galvanized rigid steel conduit, including threaded type couplings, elbows, nipples, and other fittings, shall meet the requirements of ANSI C80.1, ANSI C80.4, UL and the NEC. Do not use setscrew or threadless type couplings, bushings, elbows, nipples, and other fittings, except when approved in writing by the Engineer.

B. Acceptable Manufacturers:

1. Allied Tube and Conduit

2. Western Tube & Conduit Corporation

3. Cal Pipe Industries, Inc

4. Approved equal

2.2 RIGID POLYVINYL CHLORIDE CONDUIT (PVC) AND FITTINGS

A. PVC conduit shall be Schedule 40, UL listed for concrete encased, underground direct burial, concealed, and direct-sunlight, weather-exposed use. Provide PVC conduit manufactured from virgin PVC compounds conforming to UL 651, listed and marked for use with 90° C insulated conductors.

B. PVC conduits, couplings, elbows, nipples, and other fittings shall meet the requirements of NEMA TC 2 AND TC 3, Federal Specification W-C-1094, NEC Article 352, and ASTM D-1784 specified tests for the intended use.

C. Provide conduits having a factory formed bell on one end. Conduit that requires the use of couplings for straight runs will not be acceptable.

D. Acceptable Manufacturers:

1. Carlon/Thomas and Betts (Lamson & Sessions) Plus 40 Rigid PVC Nonmetallic Conduit

2. PW Eagle (PW Pipe)

3. Allied Tube and Conduit (Tyco)

4. Approved equal

2.3 PVC COATED RGS CONDUIT AND FITTINGS

A. PVC-coated rigid steel conduit shall be hot-dipped galvanized rigid steel conduit meeting the requirements of NEMA RN 1, UL/6, and ANSI C80.1. Provide a factory installed PVC coating, 40 mils nominal thickness, and applied over and permanently bonded to the galvanized surface. Coating shall include an interior 2 mil urethane coating.

B. All male threads on conduit, elbows, nipples and other fittings shall be protected by an application of a urethane coating; they shall be threaded and galvanized with integral plastic sleeves overlapping the plastic-coated conduit.

C. Provide PVC coated conduit suitable for conductors with 75ºC insulation.

D. Acceptable Manufacturers:

1. Robroy, Plasti-Bond Red

2. Thomas and Betts, “OCAL”

3. Perma-Cote Industries, Supreme Conduit System

4. Approved equal

2.4 FLEXIBLE METAL CONDUIT, LIQUID-TIGHT

A. Flexible metal conduit shall be UL listed per UL 360, liquid-tight, consisting of galvanized steel flexible conduit core covered with an extruded PVC jacket and terminated with nylon bushings or bushings with steel or malleable iron body and insulated throat and sealing O-ring.

B. Provide conduit with sunlight resistant outer jacket, suitable for both concealed and exposed location. Conduit shall be suitable for use in classified locations as defined by the NEC.

C. Acceptable Manufacturers:

1. Allied Tube & Conduit (Tyco), Liquid-Tuff

2. Anamet, Anaconda Sealtite Type UA

3. Electri-Flex Liquatite Type LA

4. Approved equal

2.5 FLEXIBLE NON-METALLIC CONDUIT, LIQUID-TIGHT

A. Non-metallic flexible conduit shall be seamless, liquid-tight UL 1660 listed, Type B conduit with rigid non-metallic reinforcing embedded in integral flexible PVC lining and jacket wall and shall be oil, acid, ozone and alkaline resistant, rated 105 degree C, 60 degree C wet, 70 degree C oil resistant.

B. Non metallic conduit fittings shall be dustight, liquid-tight, sunlight and chemical resistant, thermoplastic/nylon construction with tapered thread hub and integral neoprene O-ring gasket.

C. Acceptable manufacturers:

1. CARLON “CARFLEX”

2. Allied Tube & Conduit (Tyco), Liquid-Tuff

3. Hubbel/Kellems “PolyTuff I”

4. Approved equal

2.6 MISCELLANEOUS RACEWAY FITTINGS

A. Rigid Steel Fittings

1. Watertight hubs for rigid steel conduit shall be male thread type zinc-plated malleable iron with recessed "O" ring seal.

a. Acceptable Manufacturers:

1) OZ Gedney Type CHM

2) Appleton HUB Series

3) Myers Scru-Tite Hubs

4) Approved equal

2. Provide insulated throat grounding bushings at each end of every metal conduit. Provide threaded zinc-plated malleable iron grounding bushings with solderless bonding screw and insulated throat rated for 150ºC.

a. Acceptable Manufacturers:

1) Thomas & Betts Grounding and Bonding Bushings

2) OZ Gedney Type BLG

3) Appleton Threaded Grounding Bushings

4) Approved equal

3. Provide all malleable iron conduit bodies and covers with captive stainless steel screws and neoprene gaskets.

   a. Acceptable Manufacturers:

      1) Appleton Form 35 threaded Unilets

      2) Kilark

      3) Approved equal

B. PVC-Coated Rigid Steel Conduit Fittings:

1. General: All boxes and fittings used with PVC coated conduit shall be furnished with a PVC coating bonded to the metal, the same thickness as used on the coated steel conduit. The ends of couplings and fittings shall have a minimum of one pipe diameter PVC overlap to cover threads and provide a seal.

2. Provide insulated throat grounding bushings with threaded zinc-plated malleable iron grounding bushings with bonding screw and insulated throat rated for 150 degrees C.

   a. Acceptable Products:

      1) Thomas & Betts Grounding and Bonding Bushings

      2) OZ Gedney Type BLG

      3) Appleton Threaded Grounding Bushings

      4) Approved equal

3. Provide watertight and corrosion resistant hubs with a minimum 40 mil PVC exterior coating, a urethane interior coating, and pressure sealing sleeves.

   a. Acceptable Manufacturers:

      1) Robroy Plasti-Bond Red Type ST Hub

      2) Perma-Cote Industries Supreme Type ST Hub

      3) Approved equal

4. Provide corrosion resistant conduit bodies sized as required by the NEC. Provide cast iron conduit bodies and covers with captive stainless steel screws, a 40 mil minimum PVC exterior coating, 2 mil (nominal) internal urethane coating, and pressure sealing sleeves on all conduit openings.

   a. Acceptable Manufacturers:

      1) Robroy Plasti-Bond Red Conduit Bodies

      2) Perma-Cote Industries Supreme Conduit Bodies

      3) Approved equal

C. Liquid-Tight Flexible Metal Conduit Fittings:

1. Throat Connectors:

a. In NEMA 4X areas, provide zinc-plated malleable iron or galvanized steel insulated throat connectors suitable for use in wet locations, with a minimum 40 mil PVC exterior coating and pressure sealing sleeves.

b. Acceptable Manufacturers:

1) Robroy Plasti-Bond Red Liquid Tight Connectors

2) Perma-Cote Industries Supreme Liquidtight Connectors

3) Approved equal

2. Hubs:

a. In NEMA 4X areas, provide watertight and corrosion resistant hubs with a minimum 40 mil PVC exterior coating, a urethane interior coating, and pressure sealing sleeves.

b. Acceptable Manufacturers:

1) Robroy Plasti-Bond Red Type ST Hub

2) Perma-Cote Industries Supreme Type ST Hub

3) Occidental Coating Company OCAL-Blue Double-Coat Type ST Hub

4) Approved equal

3. Conduit Bodies:

a. For areas not designated NEMA 4X, provide conduit bodies sized as required by the NEC. Provide cast iron conduit bodies and covers with captive stainless steel screws and neoprene gaskets.

b. Acceptable Manufacturers:

1) Appleton Form 35 threaded Unilets

2) Crouse-Hinds Form 7 threaded condulets

3) OZ Gedney Form 7 threaded conduit bodies

4) Approved equal

c. For NEMA 4X areas, provide corrosion resistant conduit bodies sized as required by the NEC. Provide cast iron conduit bodies and covers with captive stainless steel screws, a 40 mil minimum PVC exterior coating and nominal 2 mil internal coating, and pressure sealing sleeves on all conduit openings.

d. Acceptable products:

1) Robroy Plasti-Bond Red Conduit Bodies

2) Perma-Cote Industries Supreme Conduit Bodies

3) Approved equal

4. Flexible couplings shall be type ECGJH as manufactured by the Crouse-Hinds Co.; Appleton Electric Co.; Killark Electric Manufacturing Co. or equal.

5. Explosion proof fittings shall be as manufactured by the Crouse-Hinds Co.; Appleton Electric Co.; O.Z./Gedney Co. or equal.

2.7 BOXES

A. NEMA 1 and NEMA 12 Utility Boxes:

1. Provide pressed steel switch and outlet device boxes hot-dipped galvanized after fabrication. Provide extra-depth boxes with knockouts, size and style suitable for the application.

2. Small boxes used for junction boxes or pull boxes 100 cubic inches and smaller shall be constructed of minimum 14 USS gage sheet steel, galvanized after fabrication. Provide boxes with minimum depth of 2-1/8-inches with overall size, style, and knockouts to match the application. Provide blank covers affixed with round head brass or stainless steel machine screws.

3. Boxes used for junction or pull boxes larger than 100 cubic inches shall be constructed of minimum 14 USS gage sheet steel, galvanized after fabrication. Provide boxes without knockouts with overall size and style to match the application. Provide blank covers affixed with round head brass or stainless steel machine screws. All joints shall be welded and edges ground smooth.

4. Acceptable Manufacturers:

a. Raco Manufacturing Co.

b. O.Z. Manufacturing Co.

c. Approved equal

B. NEMA 1 and NEMA 12 Terminal Boxes

1. Provide terminal boxes fabricated of sheet steel unless otherwise shown on the Drawings. Boxes shall have continuous welded seams and mounting feet. Welds shall be ground smooth. Boxes shall be flanged and shall not have holes or knockouts. Box bodies shall not be less than 14 gauge metal and covers shall not be less than 14 gauge metal. Covers shall be continuously hinged, gasketed with rolled lip, and fastened with stainless steel latches or clamps. Boxes shall be furnished with terminal mounting straps and brackets.

2. Acceptable Manufacturers:

   a. Hoffman Engineering Co.

   b. Lee Products Co.

   c. Keystone/Rees, Inc.

   d. Approved equal

C. NEMA 4 Utility Boxes

1. Provide Type FD switch and outlet device boxes of cast or malleable iron or cast copper-free aluminum as required by the application. All device boxes shall be extra depth and gasketed. Covers shall be with cadmium-zinc finish with cast iron or aluminum covers and stainless steel screws.

2. Boxes shall be UL514 listed 514 conforming to NEMA FB-1 and Federal Specification W-C-586D standards.

3. Acceptable Manufacturers:

   a. Hubbell-Killark

   b. Appleton

   c. Crouse-Hinds Co.

   d. Approved equal

D. Provide NEMA 4 terminal boxes, junction boxes, pull boxes etc., painted steel unless otherwise noted. Boxes shall have continuous welded seams and mounting feet. Welds shall be ground smooth. Boxes shall be flanged and shall not have holes or knockouts. Box bodies shall not be less than 14-gauge metal and covers shall not be less than 12 gauge metal. Covers shall be continuously hinged, gasketed, and fastened with stainless steel clamps. Terminal boxes shall be furnished with terminal mounting straps and brackets.

1. Acceptable Manufacturers:

   a. Hoffman Engineering Co.

   b. Lee Products Co.

   c. Keystone/Rees, Inc.

   d. Approved equal

E. Provide NEMA 4X terminal boxes, junction boxes, pull boxes, etc. manufactured of fiberglass reinforced plastic with stainless steel hardware unless otherwise noted. Covers shall be continuously hinged and gasketed. Terminal boxes shall be furnished with terminal mounting straps and brackets.

1. Acceptable Manufacturers:

    a. Hoffman Engineering Co.

    b. Lee Products Co.

    c. Keystone/Rees, Inc.

    d. Approved equal

F. Hazardous (Classified) Location Boxes

1. Explosion-proof boxes shall be designed for Class 1, Group D, Division 1 hazardous locations, and shall also have O-ring seals to meet NEMA 4 requirements. Boxes shall be aluminum, with stainless steel hinged covers and stainless steel bolts; Type EJB-N4 as manufactured by the Crouse-Hinds Co.; Appleton Electric Co.; Adalet-PLM or equal.]

2.8 WIREWAYS

A. For areas designated NEMA 1, or NEMA 12 on the Drawings, provide UL listed, hinged cover, NEMA 12 wireway bodies and covers fabricated from 16 gauge steel minimum, with an enamel or epoxy finish.

1. Acceptable Manufacturers:

    a. Square D Square-Duct Wireway

    b. Hoffman

    c. Approved equal

B. For all other areas or where NEMA 3R, NEMA 4, or NEMA 4X is shown on the Drawings, provide UL listed, raintight, hinged cover NEMA 4X wireway bodies and covers fabricated from stainless steel.

1. Acceptable Manufacturers:

    a. Square D

    b. Hoffman

    c. Approved equal

2.9 RACEWAY SUPPORTS AND FITTINGS

A. General: Raceways shall be supported using trapeze hangers, flush mounted hardware, conduit racks, and conduit hangers as shown on the Drawings and as required.

B. For areas not designated as NEMA 4X on the Drawings, supports and fittings for support systems for electrical equipment and raceways shall be channel supports sized to meet specified load requirements. Finish shall be hot-dipped galvanized after fabrication for strut, pipe straps, clamp back spacers, hanger rod, strut nuts, u-bolts, beam clamps, and all other supports and fittings.

1. Acceptable Manufacturers:

    a. Unistrut

    b. B-Line

    c. Power Strut

C. For areas designated as NEMA 4X on the Drawings; supports and fittings for support systems for electrical equipment and raceways shall be channel supports sized to meet load requirements.

1. Materials of construction shall be 40 mil PVC coated hot-dipped galvanized steel, 316 stainless steel, or self-extinguishing fiberglass which meets UL94V-0 flammability tests, for strut, pipe straps, clamp back spacers, hanger rod, strut nuts, U-bolts, beam clamps, and other supports and fittings.

2. Support material used shall be resistant to the material resident in the location where installed.

3. Acceptable Manufacturers:

    a. Robroy Plasti-Bond-Red PVC Coated Steel Strut and accessories

    b. Fiberglass Strut and accessories

    c. Perma-Cote Supreme PVC Coated Steel Channel and accessories

    d. Approved equal

2.10 EXPANSION AND DEFLECTION COUPLINGS

A. General: Provide expansion and/or deflection couplings for use where shown and wherever conduit crosses an expansion joint. The couplings shall alleviate longitudinal, angular, and shear conduit stress caused by thermal expansion and/or differential settlement.

B. Couplings shall be suitable for either rigid metallic or non-metallic conduits and for embedded or exposed applications.

C. Requirements:

1. Suitable for wet locations, corrosion resistant

2. Axial expansion or contracting up to 3/4 inch

3. Angular misalignment of the axes of the coupled conduit runs in any direction up to 30 degrees

4. Parallel misalignment of the axes of coupled conduit runs in any direction up to 3/4 inch

5. Watertight flexible neoprene corrosion resistant outer jacket

6. Integral flexible copper braid grounding straps to assure grounding continuity

7. Stainless steel jacket clamps

8. Integral Erickson union

9. Couplings shall comply with UL standard 514B.

10. Acceptable Manufacturers:

    a. Crouse-Hinds Type XD

    b. Appleton, Type DF

    c. O.Z. Gedney Co. Type AXDX

    d. Thomas and Betts, Type XD

    e. Approved equal

2.11 CONDUIT TAGS

A. Refer to Section 16075

2.12 CONDUIT WALL PENETRATION SEALS AND SLEEVES

A. General

1. Conduit penetrations into buildings or structures slabs or walls shall be sealed to prevent infiltration of water into or out of the structure.

2. Provide modular, mechanical type conduit penetration seals consisting of fanged rubber type or interlocking synthetic rubber (EPDM) links shaped to continuously fill the annular space between the conduit and the opening or cast sleeve. The elastomeric element shall be sized and selected per the manufacturer's recommendations for the application shown on the Drawings. At a minimum, the seals shall be suitable for use in standard service applications (-40° F to 250° F) unless noted otherwise.

3. Sleeves shall be thermoplastic with water stops, suitable for poured wall construction.

4. Conduit penetration seals and sleeves shall be complete assemblies supplied by a single manufacturer.

5. Provide suitable seal for either conduit sleeve application or direct in core drilled wall penetration as required shown on the Contract Documents.

6. Acceptable products: O-Z Gedney Type CSM; Thunderline Corporation Link-Seal and Plastic Sleeves; Calpico Inc. Pipe Linx and Plastic Sleeves; or approved equal.

2.13 DUCT SEAL

A. General Penetration Sealant

1. Provide non-hardening compound designed as a waterstop and moisture barrier for sealing the conduit annular space between conduit and electrical conductors. Material shall also be suitable for use around conduit entrance points including service conduits wood, metal, or other materials where shown on the Drawings. Seal material shall be asbestos free, non-toxic, and non-corrosive to metals and plastic, including wire insulation. Material shall be reusable, paintable. And suitable for locations with thermal expansion and contraction.

2. Acceptable Products:

a. O-Z Gedney DUX

b. Rainbow Technology, Duct Seal Putty

c. Approved equal

B. Fire Rated Penetration Sealant

1. Provide conduit penetration and cable sealant similar to general penetration sealant except provide material with fire rating that meets or exceeds the wall or floor construction as shown on the Drawing. Material shall be solvent free and UL or FM approved for the application.

2. Acceptable Products:

a. Thomas & Betts Corp.; Pro Set Systems

b. Neer Mfg. Co.

c. Spec Seal, LCI Sealant

d. McMaster-Carr, 9340

e. Approved equal with fire rating as required for the application.

PART 3 EXECUTION

3.1 GENERAL

A. Check the approximate locations of raceway system components shown on drawings for conflicts with openings, structural members, and components of other systems and equipment having fixed locations. In the event of conflicts, consult the Engineer. Make modifications and changes required.

B. Protection during construction: Prior to installation, store all products in a dry location. Following installation, protect products from the effects of moisture, corrosion, and physical damage during construction. Keep openings in conduit and tubing capped with manufactured seals during construction. Cover PVC conduit, elbows, and PVC coated rigid steel conduit, nipples, elbows, and fittings from exposure to sunlight.

C. Material and equipment installation: Follow manufacturer's installation instructions explicitly, unless otherwise indicated. Wherever any conflict arises between manufacturer's installation instructions, codes and regulations, and these contract documents, follow Engineer's decision. Keep copy of manufacturer's installation instructions on the jobsite available for review at all times.

D. No wire shall be pulled until the conduit system is complete in all details; in the case of concealed work, until all rough plastering or masonry has been completed; in the case of exposed work, until the conduit system has been completed in every detail.

3.2 INSTALLATION

A. Minimum size conduit shall be 3/4-inch.

B. Raceway type for location and installation method unless otherwise noted:

1. Exterior, exposed, higher than 6-inches above grade:

   a. Galvanized rigid steel conduit

2. Interior, exposed unless noted otherwise:

   a. Galvanized rigid steel conduit

3. Interior, concealed, not embedded in concrete:

   a. Rigid steel conduit

4. Clean, dry, finished areas (offices, control rooms, etc.) and above suspended ceilings for conduits 1-inch and smaller for lighting and receptacle installation:

   a. Electrical metallic tubing

5. Embedded within or below structure concrete slabs or floors; installed within concrete or CMU walls:

   a. PVC Schedule 40

6. Risers through concrete pads:

   a. PVC Coated rigid steel conduit.

7. NEMA 4X areas:

   a. PVC Coated rigid steel conduit.

8. Exterior direct buried or concrete encased ductbanks: per Section 16600

9. PVC coated rigid galvanized steel elbows shall be used for pad-mounted transformer stub-ups.

10. Conduits shall be installed using threaded fittings except for PVC or EMT. The use of running threads is prohibited. Where such threads are necessary, a 3-piece union shall be used. Rigid galvanized steel conduits which have been field cut and threaded shall be painted with cold galvanizing compounds.

11. Flexible metallic conduit (Type MC cable) shall be used for recessed fluorescent fixtures in hung ceilings to connect fixtures to the conduit system.

12. Rigid galvanized steel conduits buried in earth shall be completely painted with bitumastic.

13. PVC coated rigid galvanized steel conduit shall be used for elbows at risers at the utility pole for electrical and telephone service conduits. Rigid galvanized steel conduit shall be used at utility pole for electrical and telephone service and fire alarm conduits to a height of 10-ft above finished grade. Furnish and install weather heads at service pole riser if required by utility company.

14. Provide PVC coated rigid steel conduit under equipment mounting pads unless encased in concrete as specified herein.

15. In exterior light pole foundations; extend PVC schedule 40 conduit 6 inches above the top of the foundation or as shown on the Drawings.

16. Where conduit changes from underground direct burial to exposed; extend PVC coated rigid steel conduit up to 6 inches above finished grade or as shown on the Drawings.

17. Where exterior conduit transition through concrete walls, slabs, and floors to exposed runs, provide PVC coated rigid steel conduit with factory manufactured elbows. Extend PVC coated rigid steel conduit a minimum of 6-inches beyond the concrete walls, slabs, or floors or as shown on the Drawings.

C. PVC Coated Rigid Steel Conduit:

1. Suitable UL listed PVC coated conduits, boxes, and fittings only shall be used. Galvanized conduits with a subsequent or field application of PVC material is not acceptable.

2. Install in strict accordance with the manufacturer's instructions. Touch up any damage to the coating with conduit manufacturer acceptable patching compound. PVC boot shall cover all threads. Where belled conduits are used, bevel the unbelled end of the joint before joining. Leave no metallic threads uncovered. Clean field threads with solvent and coat with urethane touch-up. Keep two cans of urethane touch-up at each threading station.

D. Hazardous and Classified Locations

1. Conduits terminating at boxes enclosing circuit opening equipment shall be sealed at the entrance to the enclosure with approved compound filled sealing fittings to prevent passage of explosive or combustible gases through the conduits.

2. All conduits leading from or entering hazardous locations shall be similarly sealed at each point of entrance or exit.

3. Exposed conduits passing through hazardous locations shall be sealed at both the entrance to and the exit from the hazardous locations.

4. A sealing compound installation schedule shall be presented to the Engineer for approval. Each installation shall be signed off by the Contractor and the Engineer and each fitting shall be legibly marked with red paint to indicate that the sealing compound has been installed.

5. Conduit sealing and drain fittings shall be installed in all hazardous (classified) areas designated Class 1, Division 1, and Class 1, Division 2.

E. Location, Routing, and Grouping:

1. Conceal or expose raceways as indicated on the Drawings. Group raceways in same area together. Locate raceways at least 12 inches away from parallel runs of heated piping for other utility systems.

2. Run exposed raceways parallel or perpendicular to walls, structural members, or intersections of vertical planes to provide a neat appearance. Follow surface contours as much as possible. No diagonal runs will be allowed. All conduits shall be run plumb, straight, and true.

3. Run concealed raceways with the minimum of bends in the shortest practical distance considering the building construction and other systems.

4. In block walls, do not route raceways in the same horizontal course with reinforcing steel.

5. In outdoor, underground, or wet locations, use watertight couplings and connections in raceways. Install and equip boxes and fittings so as to prevent water from entering the raceway.

6. Do not notch or penetrate structural members for passage of raceways except with prior approval of the Engineer.

7. Do not run raceways horizontally in equipment foundation pads.

8. Separate raceway in slabs not less than three times the largest raceway outside diameter minimum, except at raceway crossings, and then only with the approval of the Engineer. Embed conduits in walls, floors, slabs, or overhead in the middle one-third of the concrete and at least 3-inches from the concrete surface; thicken slabs where necessary to accommodate conduits in a manner as approved by the Engineer.

9. Do not route raceways exposed across walkways unless approved conduit threshold coverings are provided.

10. Route conduits within the furring lines of building walls and ceilings unless specifically noted to be exposed.

11. Provide all necessary sleeves and chases required where conduits are routed through floors or walls; seal all openings and finish to match adjacent surfaces.

12. Where conduit routing changes from concrete embedded within floors, slabs, or equipment pads to exposed, maintain a minimum separation of 6-inches between the closest wall, pad, or structure face and the outer edge of the exposed conduit.

13. Where conduits are routed through openings in walls or floor slabs, the remaining openings shall be sealed against the passage of flame and smoke in accordance with UL requirements and the details shown on the Drawings. The sealing method shall have a UL fire rating, which equals or exceeds the fire rating of the wall or floor construction.

14. Conduits shall not be routed to cause obstruction of passageways to pedestrian or vehicular traffic. Conduits shall not be routed across pipe shafts, access hatches or vent duct openings. They shall be routed to avoid such present or future openings in floor or ceiling construction.

15. Conduits routed from heated to unheated spaces, exterior spaces, refrigerated spaces, cold air plenums, etc, shall be sealed with "Duxseal" as manufactured by Manville or seal fitting to prevent the accumulation of condensation.

16. Conduits shall be routed a minimum of 3-in from steam or hot water piping. Where crossings are unavoidable, the conduit shall be kept at least 1-in from the covering of the pipe crossed.

17. A mandrel shall be pulled through all existing conduits to be reused under this Contract and through all new conduits 2-in in diameter and larger. Conduits shall be proved with the mandrel prior to installation of any conductors.

18. Emergency (generator) source and normal (power company) source feeders shall not be run through the same pull box.

F. Box Applications

1. Unless otherwise specified herein or shown on the Drawings, all boxes shall be metal.

2. Pull boxes, junction boxes, or terminal boxes shall be used in any conduit run where a splice is required. Pull boxes shall be provided every 200 feet of straight run, every 150 feet with 90 degrees of bends, every 100 feet with 180 degrees of bends, and every 50 feet with 270 degrees of bends.

3. Where no type or size is indicated for junction boxes, pull boxes or terminal cabinets, they shall be sized in accordance with the requirements of the NEC. Enclosure type and material shall be as specified herein.

4. Exposed switch, receptacle and lighting outlet boxes and condulet fittings shall be cast or malleable iron, except that cast aluminum shall be used with aluminum conduit and non-metallic PVC shall be used with PVC.

5. Concealed switch, receptacle and lighting outlet boxes shall be pressed steel.

6. Terminal boxes, junction boxes and pull boxes shall have NEMA ratings suitable for the location in which they are installed, as specified in Section 16000.

7. Boxes flush in block, brick or tile walls shall be located at a course line and provided with square tile covers. Flush boxes shall not project beyond the finished surfaces nor shall surfaces project more than 1/8-in beyond the box enclosure. Wiring devices located in close proximity to each other shall be installed in one solid gang box with single cover.

8. All conduit bodies and pulling outlets shall comply with NEC wire bending space requirements. Mogul type fittings shall be used for sizes 2-1/2-in and larger.

9. Conduit terminating in pressed steel boxes shall have double locknuts and insulated bushings

10. PVC conduit to non-metallic box connections shall be made with PVC socket to male thread terminal adapters with neoprene O-ring and PVC round edge bushings.

11. PVC boxes, conduit fittings, etc, with integral hubs shall be solvent welded directly to the PVC conduit system.

12. Non-metallic boxes with field drilled or punched holes shall be connected to the PVC conduit system with threaded and gasketed PVC Terminal Adapters.

G. Final connection to equipment subject to movement or vibration:

1. Provide liquid-tight, PVC-jacketed flexible conduit for final connection to motors, wall or ceiling mounted fans and unit heaters, dry type transformers (primary and secondary terminations), generator terminations, valves, local instrumentation, and other equipment where flexible connection is required for vibration and to facilitate removal or adjustment of equipment.

2. Provide 18-inch minimum, 60-inch maximum lengths unless otherwise approved by the Engineer. Provide flexible conduit size for installations of 4 inches or less. For larger sizes, use rigid steel conduit as specified.

3. The flexible conduit length shall be sufficient to allow the connected equipment to be withdrawn and fully moved off its base.

4. Non-metallic flexible conduit may be used for such connections when part of rigid PVC conduit systems.

5. Flexible couplings shall be used in hazardous locations for all motor terminations and other equipment where vibration is present.

H. Wireways: Mount wireways securely in accordance with the NEC and manufacturer's instructions. Orient cover on accessible vertical face of wireway to allow removal of all fasteners and complete removal or rotation of cover for installation of conductors.

I. Raceway Supports

1. General:

a. Support raceways at intervals not exceeding NEC requirements unless otherwise indicated. Supports shall be provided to ensure a rigid and durable installation.

b. Support all raceways from structural members only. Do not support from pipe hangers or rods, cable tray, or other conduit.

c. Support flexible metal conduit with conduit clamps, except where the flexible metal conduit is fished and where sections less than 4 feet in length are used in concealed areas to supply lighting fixtures in accordance with the NEC. Adjustable steel and plastic band hangers, adjustable band hangers, adjustable swivel ring hangers and J-hangers are not acceptable.

d. Attachment to concrete shall be cast-in-place inserts, cast-in place welded plates with welded studs or stainless steel adhesive anchors.

e. Do not use nails anywhere or wooden plugs inserted in concrete or masonry as a base for raceway or box fastenings. Do not weld raceways or pipe straps to steel structures. Do not use wire in lieu of straps or hangers.

f. All reinforcing bars shall be located by the Contractor with the use of a rebar locator prior to installing adhesive capsule type anchors. Mark the location of all reinforcing bars in an area bounded by a line drawn at least 18-in from the edge of the support bearing/weld plates on all four sides of the bearing/weld plates prior to fabricating and installing bearing/weld plates.

g. Where interference occurs, adjust anchor locations to clear reinforcing bars and alter support configuration at no additional cost to the Authority.

h. Miscellaneous steel for the support of fixtures, boxes, transformers, starters, contactors, panels and conduit shall be furnished and installed. Channel supports shall be ground smooth and fitted with plastic end caps.

i. Steel channels, flat iron and channel iron shall be furnished and installed for the support of all electrical equipment and devices, where required, including all anchors, inserts, bolts, nuts, washers, etc, for a rigid installation. Channel supports shall be ground smooth and fitted with plastic end caps.

2. PVC conduit shall be supported with non-metallic clamps, non-metallic racks and stainless steel hardware.

3. Single conduits shall be supported by means of one-hole pipe clamps in combination with one-screw back plates, to raise conduits from the surface.

4. Multiple runs of conduits shall be supported on fabricated channel trapeze type racks with steel horizontal members and threaded hanger rods. The rods shall be not less than 3/8-in diameter. Surface mounted panel boxes, junction boxes, conduit, etc, shall be supported by spacers to provide a minimum of 1/2-in clearance between wall and equipment.

   a. Conduit support trapezes shall be vertically supported every 10-ft or less, as required to obtain rigid conduit construction.

   b. Lateral restraints (sway bracing) shall be spaced 30-ft or less.

   c. Horizontal restraints shall be spaced at 40-ft or less. There shall be at least one horizontal restraint per horizontal run.

   d. Trapeze attachment to structural steel shall be by beam clamps or welded beam attachment. C-clamps will not be allowed for vertical hangers.

5. Conduit Racks

   a. Support shall be spaced 10-ft or less, as required to obtain rigid conduit construction.

6. Conduit Hangers

   a. Conduit hangers shall be vertical supported 10-ft or less.

   b. Attachment to structural steel shall be by beam clamps or welded beam attachment. C-clamps will not be allowed for vertical hangers.

J. Bends

1. Make changes in direction of runs with symmetrical bends or cast metal fittings. Make bends and offsets of the longest practical radius. Avoid field-made bends and offsets where possible, but where necessary, make with an acceptable hickey or conduit bending machine. Do not heat metal raceways to facilitate bending.

2. Make bends in parallel or banked runs of raceways from the same center or centerline so that bends are parallel, concentric. and of neat appearance. Factory elbows may be used in parallel or banked raceways if there is a change in the plane of the run and the raceways are of the same size. Otherwise, make field bends in parallel runs.

3. For PVC Schedule 40 conduits, use factory made elbows for all bends 30 degrees or larger. Use acceptable heating methods for forming smaller bends.

4. Make no bends in flexible conduit that exceed allowable bending radius of the cable to be installed or that significantly restricts the conduits flexibility.

K. Threaded Joints

1. Paint all field-cut threads with zinc rich paint or liquid galvanizing compound for rigid steel conduit and for PVC-coated rigid steel conduit after removal of chips and cleaning with solvent. Touch up after assembly to cover nicks or scars.

2. Use approved, highly conductive jointing compound on all joints, Appleton Type TLC, or approved equal.

L. Bushings, Hubs, and Insulating Sleeves:

1. Where rigid steel conduit, PVC coated rigid steel conduit, or liquid-tight flexible metal conduit enters metal cabinets/enclosures, install an insulated throat grounding bushing on the end of each conduit. Install a bonding jumper from the bushing to suitable equipment ground bus or ground pad. Ground pads designated for instrumentation signal grounds as specified in Division 13 shall not be used for this purpose.

2. Interconnection or daisy-chaining of bonding jumpers from each conduit grounding bushing to the equipment ground bus or ground pad is acceptable.

3. If neither a ground bus or ground pad exists, connect the bonding jumper to the metallic enclosure with a listed bolted-lug connection.

4. All connections between conduits and NEMA 1, 1A, and 12 enclosures shall be made with hubs outside and bushings on the inside.

5. Conduit connections to NEMA 3R, NEMA 4, or NEMA 4X enclosures, junction boxes, terminal junction boxes, or device outlet boxes, shall be made with watertight, corrosion resistant hubs. The conduit connections shall maintain the integrity of the enclosure NEMA rating.

M. Raceway Penetrations:

1. Seal the interior of all raceways entering structures or buildings at the first box or outlet with duct seal to prevent the entrance into or exit from the structure of gases, liquids, or rodents.

2. All underground conduit penetrations at walls or other structures shall be sealed watertight using wall seals in core drilled openings or with specified conduit wall sleeves. Conduit wall seals and sleeves shall be used in accordance with the manufacturer's installation instructions and the details shown on the Drawings.

3. Below Grade Penetrations or Penetrations Through Walls of Water Bearing Structures.

   a. Where conduit enters a new structure below grade through a concrete slab or wall, or where conduit penetrates a new wall of a water bearing structure, install a watertight mechanical conduit penetration seal and sleeve. Cast the conduit sleeve directly into the concrete wall or floor slab as shown on the Drawings. Install the sealing assembly such that it may be tightened at any time from the interior or dry side.

   b. Where conduit enters an existing structure below grade through a concrete wall or where conduit penetrates a new wall of a water bearing structure, core drill through the existing wall and install a watertight conduit penetration seal. Install the sealing assembly such that it may be tightened at any time from the interior side.

   c. For wall thicknesses less than 12-inches, dry pack around the conduit and the sealing assembly on the exterior side with non-shrink grout as shown on the Drawings. Provide double sealing for walls thicknesses 12-inches and greater.

   d. For concrete surfaces having moisture membranes, provide dual seals with suitable membrane clamp as shown on the Drawings.

4. Above Grade Penetrations

   a. Seal all above grade penetrations of concrete, CMU, metal, or wooden walls or roofs with duct seal. Install duct seal around conduit penetrations and inside conduits for sealing the annular space between conduit and conductors.

   b. Where raceways penetrate fire-rated walls, floors, or ceilings, provide fire stop material as specified herein or per Division 7 [Section 07 84 00] in openings around electrical penetrations to maintain the fire-resistance rating.

5. Gas Containment Area Sealing: Internally and externally seal each conduit entering or leaving any area containing noxious gases to prevent contamination into clean areas via the conduit system. Areas requiring this protection are rooms where chlorine, ammonia and ozone are stored, generated or handled. Caulking material for conduit internal use shall be synthetic elastomer type, 3M, Series CP25 or equal. External sealing shall be in accordance with the typical details shown on the Drawings.

6. Liquid Chemical Containment Area Sealing: Internally and externally seal each conduit entering or leaving any liquid chemical containment areas to prevent chemical migration or drainage via the conduit system. Sealing shall be in accordance with the typical details shown on the Drawings. Seal conduits with a polyurethane elastomeric caulking material installed in accordance with the manufacturer's instructions. The material shall be SikaFlex-2C used with the primer No. 449 or No. 260 as appropriate for the conduit or approved equal.

N. Expansion Joints:

1. Provide expansion/deflection fittings for raceways crossing expansion joints in structures, between structures and walkways or concrete slabs to compensate for expansion, contraction, and deflection. Provide for the high rate of thermal expansion and contraction of PVC conduit by providing PVC expansion joints as recommended by the manufacturer and as required. See Structural Drawings for locations of expansion joints.

2. Provide expansion only fittings on exposed, rigid steel conduit runs a minimum of every 200 feet or as required for the specific thermal characteristics of the application.

3. Provide bonding jumpers around expansion joint fittings.

3.3 PREPARATION FOR PULLING IN CONDUCTORS

A. Do not install crushed or deformed raceways. Do install conductors in cruised or deformed raceways.

B. Install raceways to avoid introduction of traps.

C. Immediately after installation, plug or cap all raceway ends with watertight and dust-tight seals until the time for pulling in conductors. Take care to prevent the lodging of plaster, concrete, dirt, or trash in raceways, boxes, fittings, and equipment during the course of construction. Make raceways entirely free of obstructions or replace them.

D. Ream all raceways, remove burrs, and clean raceway interior before introducing conductors or pull wires.

E. For concrete-encased raceways (after the concrete envelope has set), and for direct buried conduits, pull a mandrel through each raceway to remove debris. Pull a mandrel of a diameter approximately 1/4 inch less than the raceway inside diameter, through each raceway. Use cleanout or flexible mandrels for conduit sizes greater than 2-inches; use rubber/foam mandrel for conduit sizes 2-inches and below.

F. For all raceways which contain less than 50 percent of the NEC allowed fill of control cables or individual conductors, install a nylon pull rope with the conductors.

3.4 EMPTY RACEWAYS

A. Certain raceways will have no conductors pulled in as part of this Contract. Identify with conduit tags at each end and at any intermediate pull point of each such empty, spare raceways.

B. Raceways noted as spare shall be capped or plugged at both ends with easily removable conduit cap fittings

C. Provide a fabricated, listed removable cap over each end of empty raceways. Provide cap with eyelet for tying off pull rope.

D. 3/16-in polypropylene pull lines shall be installed in all new or existing unused conduits noted as spares or designated for future equipment. Provide a nylon pull rope with a minimum of 3-feet of slack length at each end of each empty raceway. Tie off the pull rope at the conduit end cap eyelet.

3.5 IDENTIFICATION

A. Attach conduit identification tags to conduits with 304 stainless steel hose clamps and/or stainless steel jack chains.

B. Provide conduit identification tags for all conduits at each end of conduit and at least once in every 50 feet of exposed conduit runs.

C. Provide conduit identification tags for each conduit inside all manholes and handholes.

D. Conduits installed higher than 15 feet above finished grade or finished floor elevations shall be provided with large plastic identification nameplates at these locations. Attach plastic nameplates with plastic ties.

3.6 PAINTING

A. Paint exposed metal raceway systems in accordance with the requirements of Section 09900.

END OF SECTION

APPENDIX 16130-A
CONDUIT SCHEDULES

The Schedules are prepared as a guide to the Contractor and additional circuits from home runs, specialty manufactured cables, and supplier specific wiring may require additional conductors not specifically included in the schedule. Such items not included in the Schedules shall not relieve the Contractor of the responsibility of furnishing and installing the necessary cables and raceways as required by the remainder of the Contract Documents for a fully functioning and operational system.

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CONDUIT SCHEDULE						
Conduit Tag	**Size [in.]**	**Fill**	**From**	**To**	**Dwg Ref.**	**Comments**
C14010	1 1/4	(2)#14-C	14-CP-03	14-HS-P50	14-E-01	(E) CONDUIT #I1410 TO BE REUSED AND RENAMED TO CONDUIT TAG AS SHOWN. REMOVE EXISTING WIRES AND REPLACE WITH NEW. SEE NOTE 1
C14011	1 1/4	(2)#14-C	14-CP-03	14-HS-P55	14-E-01	(E) CONDUIT #I1411 TO BE REUSED AND RENAMED TO CONDUIT TAG AS SHOWN . SEE NOTE 1
C14012	1 1/4	(2)#14-C	14-CP-03	14-SSL-P50	14-E-01	(E) CONDUIT #I1412 TO BE REUSED AND RENAMED TO CONDUIT TAG AS SHOWN. REMOVE EXISTING WIRES AND REPLACE WITH NEW. SEE NOTE 1
C14013	1 1/4	(2)#14-C	14-CP-03	14-SSL-P55	14-E-01	(E) CONDUIT #I1413 TO BE REUSED AND RENAMED TO CONDUIT TAG AS SHOWN. REMOVE EXISTING WIRES AND REPLACE WITH NEW. SEE NOTE 1
C14014	1 1/4	(8)#14-C, (8)#12-C	14-CP-03	14-ZSH/ZSL/SV-52	14-E-01	(E) CONDUIT #I1414 TO BE REUSED AND RENAMED TO CONDUIT TAG AS SHOWN. REMOVE EXISTING WIRES AND REPLACE WITH NEW. SEE NOTE 1
C14015	1 1/4	(4)#14-C, (4)#12-C	14-CP-03	14-ZSH/ZSL/SV-57	14-E-01	(E) CONDUIT #I1415 TO BE REUSED AND RENAMED TO CONDUIT TAG AS SHOWN. REMOVE EXISTING WIRES AND REPLACE WITH NEW. PROVIDE PARTIAL CONDUIT WITH NEW AS SHOWN ON DWG. SEE NOTE 1
C14016	1 1/4	(8)#14-C, (8)#12-C	14-CP-03	14-ZSH/ZSL/SV-54	14-E-01	(E) CONDUIT #I1416 TO BE REUSED AND RENAMED TO CONDUIT TAG AS SHOWN. REMOVE EXISTING WIRES AND REPLACE WITH NEW PROVIDE PARTIAL CONDUIT WITH NEW AS SHOWN ON DWG. SEE NOTE 1

Conduit Tag	Size [in.]	Fill	From	To	Dwg Ref.	Comments
C14017	1 1/4	(4)#14-C, (4)#12-C	14-CP-03	14-ZSH/ZSL/SV-59	14-E-01	(E) CONDUIT #I1417 TO BE REUSED AND RENAMED TO CONDUIT TAG AS SHOWN. REMOVE EXISTING WIRES AND REPLACE WITH NEW. SEE NOTE 1
C14100	1 1/4	(10)#14-C	(E) 14-CP-01	52-CP-01	52-E-03	DRYER INTERLOCKS. SEE NOTE 1
C14113	3/4	(2)#14-C	14-LP-10	14-CS-P60	14-E-01	NOTE 1
C14114	3/4	(4)#14-C	14-LP-10	14-CS-P65-1/14-CS-P65-02	14-E-01	NOTE 1
C14114A	3/4	(2)#14-C	14-LP-10	14-CS-P65-2	14-E-01	VIA P14114. SEE NOTE 1
P14110	1 1/4	(3)#6, (1)#10-G	DPB1	14-LP-10	14-E-01	NOTE 1
P14113	1	(3)#12, (2)#14-C, (1)#12-G	14-LP-10	14-ME-03-DWS, SSL-P60	14-E-01	NOTE 1
P14114	1	(3)#12, (2)#14-C, (1)#12-G	14-LP-10	14-ME-04-DWS, SSL-P65	14-E-01	NOTE 1
C15005	1	(6)#14-C	MVSG1	XFMR-N	15-E-01	
C15010	1	(6)#14-C	MVSG1	XFMR-S	15-E-01	
C15101	1 1/2	(20)#14-C	SWGR D	GEN-2	15-E-02	GEN START SIGNAL, ETC.
CX15101	2"	PULL ROPE	SWGR D	HH-P113	15-E-02	
FO15001	1	(1) 12 FO CABLE	16-FO-02	SWGR DA	15-E-01	
FO15002	1	(1) 12 FO CABLE	16-FO-02	SWGR DB	15-E-01	
FO15003	1	(1) 12 FO CABLE, (4) FOPC	16-FO-02	MVSG1	15-E-01	ROUTE 4-FOPC TO SWGR A WITHOUT TERMINATING AT 16-FO-02
FO15004	1	(1) 12 FO CABLE	16-FO-02	GEN-2	15-E-02	
FO15010	1	(4) FOPC	MVSG1	SWGR D MAIN BREAKER	15-E-01	ARC FLASH NETWORK CABLES
L15101	1	(3)#10, (1)#10-G	(E) PNL B2	GEN-2 HEATER	15-E-02	PROVIDE NEW CABLES IN EXISTING CONDUIT
L15102	1	(8)#10, (1)#10-G	(E) PNL B2	GEN-2 BATTERY CHARGER, CONTROL PANEL, RECEPTACLE, LIGHT	15-E-02	PROVIDE NEW CABLES IN EXISTING CONDUIT
L15103	1	(6)#10, (1)#10-G	(E) PNL B2	GEN-2	15-E-02	PROVIDE NEW CABLES IN EXISTING CONDUIT
M15005	1 1/2	(3)#2, (1)#6-G	MVSG1	XFMR-N	15-E-01	
M15010	1 1/2	(3)#2, (1)#6-G	MVSG1	XFMR-S	15-E-01	
N15101	1 1/4	(2)Cat6-C	SWGR D DMM	(E) 16-CP-01	16-E-01	
P15001A	4	(4)#500KCMIL, (1)#250KCMIL-G	GEN 2	SWGR D	15-E-01	
P15001B	4	(4)#500KCMIL, (1)#250KCMIL-G	GEN 2	SWGR D	15-E-01	
P15001C	4	(4)#500KCMIL, (1)#250KCMIL-G	GEN 2	SWGR D	15-E-01	

Conduit Tag	Size [in.]	Fill	From	To	Dwg Ref.	Comments
P15001D	4	(4)#500KCMIL, (1)#250KCMIL-G	GEN 2	SWGR D	15-E-01	
P15001E	4	(4)#500KCMIL, (1)#250KCMIL-G	GEN 2	SWGR D	15-E-01	
PX15001A	4	PULL ROPE	SWGR DA	HH-P101	E-03	
PX15001B	4	PULL ROPE	SWGR DA	HH-P101	E-03	
PX15001C	4	PULL ROPE	SWGR DA	HH-P101	E-03	
PX15051A	4	PULL ROPE	SWGR DB	HH-P111	E-03	
PX15051B	4	PULL ROPE	SWGR DB	HH-P111	E-03	
PX15051C	4	PULL ROPE	SWGR DB	HH-P111	E-03	
SX15001	1	PULL ROPE	SWGR D	HH-S111	E-03	
SX15002	1	PULL ROPE	SWGR D	HH-S111	E-03	
SX15003	1	PULL ROPE	SWGR D	HH-S111	E-03	
U15001A	6	PULL ROPE	PG&E SERVICE	MVSG1	15-E-01	
U15001B	6	PULL ROPE	PG&E SERVICE	MVSG1	15-E-01	
C16100	2	(36)#14-C	MCC-B1	16-CP-02	16-E-01	
C16150	2	(36)#14-C	MCC-B1	16-CP-02	16-E-01	
FO16010	1	(4) FOPC	16-FO-02	SWGR A MAIN BREAKER	16-E-01	ARC FLASH NETWORK CABLES ROUTED VIA FO15003
FO16101	1	(2) 12 FO CABLE	16-FO-02	16-CP-02	16-E-01	
FO16102	1	(1) 12 FO CABLE	16-FO-02	16-FO-01	16-E-01	
N16100	1 1/4	(6)Cat6-C	16-CP-02	(E) 16-CP-01	16-E-01	
N16101	3/4	(2)Cat6-C	(E) SWGR A VIA JBOX	16-CP-02	16-E-01	
P16001A	4	(3)#500KCMIL, (1)#500KCMIL-G	XFMR-N	CABLE/BUS TAP BOX	16-E-01	
P16001B	4	(3)#500KCMIL, (1)#500KCMIL-G	XFMR-N	CABLE/BUS TAP BOX	16-E-01	
P16001C	4	(3)#500KCMIL, (1)#500KCMIL-G	XFMR-N	CABLE/BUS TAP BOX	16-E-01	
P16001D	4	(3)#500KCMIL, (1)#500KCMIL-G	XFMR-N	CABLE/BUS TAP BOX	16-E-01	
P16001E	4	(3)#500KCMIL, (1)#500KCMIL-G	XFMR-N	CABLE/BUS TAP BOX	16-E-01	
P16001F	4	(3)#500KCMIL, (1)#500KCMIL-G	XFMR-N	CABLE/BUS TAP BOX	16-E-01	
P16001G	4	(3)#500KCMIL, (1)#500KCMIL-G	XFMR-N	CABLE/BUS TAP BOX	16-E-01	
P16001H	4	(3)#500KCMIL, (1)#500KCMIL-G	XFMR-N	CABLE/BUS TAP BOX	16-E-01	
P16001I	4	(3)#500KCMIL, (1)#500KCMIL-G	XFMR-N	CABLE/BUS TAP BOX	16-E-01	

Conduit Tag	Size [in.]	Fill	From	To	Dwg Ref.	Comments
P16001J	4	(3)#500KCMIL, (1)#500KCMIL-G	XFMR-N	CABLE/BUS TAP BOX	16-E-01	
P16001K	4	(3)#500KCMIL, (1)#500KCMIL-G	XFMR-N	CABLE/BUS TAP BOX	16-E-01	
C21101	2	(24)#14-C, (8)#14-S	51-CP-01	AREA 21 MOVS	21-E-01	
C21121	1	(6)#14-C, (2)#14-S	CONDUIT C21101	21-V-02-AA	21-E-01	FROM 51-CP-01 VIA C21101
C21122	1	(6)#14-C, (2)#14-S	CONDUIT C21101	21-V-04-AA	21-E-01	FROM 51-CP-01 VIA C21101
C21123	1	(6)#14-C, (2)#14-S	CONDUIT C21101	21-V-06-AA	21-E-01	FROM 51-CP-01 VIA C21101
C21124	1	(6)#14-C, (2)#14-S	CONDUIT C21101	21-V-08-AA	21-E-01	FROM 51-CP-01 VIA C21101
EL21000	2	(18)#12, (9)#12-G	LP-B5U	AREA 21 INSTRUMENTS	21-E-01	
EL21001	3/4	(2)#12, (1)#12-G	CONDUIT EL21000	21-AE/AIT-E10-1	21-E-01	FROM 51-CP-01 VIA EL21000
EL21002	3/4	(2)#12, (1)#12-G	CONDUIT EL21000	21-AE/AIT-E10-2	21-E-01	FROM 51-CP-01 VIA EL21000
EL21003	3/4	(2)#12, (1)#12-G	CONDUIT EL21000	21-AE/AIT-E10-3	21-E-01	FROM 51-CP-01 VIA EL21000
EL21004	3/4	(2)#12, (1)#12-G	CONDUIT EL21000	21-AE/AIT-E10-4	21-E-01	FROM 51-CP-01 VIA EL21000
EL21005	3/4	(2)#12, (1)#12-G	CONDUIT EL21000	21-AE/AIT-E10-5	21-E-01	FROM 51-CP-01 VIA EL21000
EL21020	3/4	(2)#12, (1)#12-G	CONDUIT EL21000	21-FE/FIT-E20	21-E-01	FROM 51-CP-01 VIA EL21000
EL21021	3/4	(2)#12, (1)#12-G	CONDUIT EL21000	21-FE/FIT-E21	21-E-01	FROM 51-CP-01 VIA EL21000
EL21022	3/4	(2)#12, (1)#12-G	CONDUIT EL21000	21-FE/FIT-E22	21-E-01	FROM 51-CP-01 VIA EL21000
EL21023	3/4	(2)#12, (1)#12-G	CONDUIT EL21000	21-FE/FIT-E23	21-E-01	FROM 51-CP-01 VIA EL21000
L21110	3/4	(6)#12, (3)#12-G	LP-B5A	HH-P106	E-04	
L21111	3/4	(2)#12, (1)#12-G	HH-P106	OX DITCH 1 LTG; CKT 1	21-E-02	TO LP-B5A VIA LP21110
L21112	3/4	(2)#12, (1)#12-G	HH-P106	OX DITCH 1 RECEPTS; CKT 2	21-E-02	TO LP-B5A VIA LP21110
L21113	3/4	(2)#12, (1)#12-G	HH-P106	OX DITCH 1 LTG; CKT 3	21-E-02	TO LP-B5A VIA LP21110
L21160	3/4	(4)#12, (2)#12-G	LP-B5B	HH-P106	E-04	
L21161	3/4	(2)#12, (1)#12-G	HH-P106	OX DITCH 1 LTG; CKT 1	21-E-02	TO LP-B5B VIA LP21160
L21162	3/4	(2)#12, (1)#12-G	HH-P106	OX DITCH 1 RECEPTS; CKT 2	21-E-02	TO LP-B5B VIA LP21160
N21101	1	(1) 3/C RS-485	51-CP-01	21-ME-01-ML	21-E-01	
N21102	1	(1) 3/C RS-485	21-ME-01-ML	21-ME-02-ML	21-E-01	
N21103	1	(1) 3/C RS-485	21-ME-02-ML	21-ME-03-ML	21-E-01	
N21104	1	(1) 3/C RS-485	21-ME-03-ML	21-ME-04-ML	21-E-01	
N21105	1	(1) 3/C RS-485	21-ME-04-ML	21-ME-05-ML	21-E-01	
N21106	1	(1) 3/C RS-485	21-ME-05-ML	21-ME-06-ML	21-E-01	
P21100A	3	(6)#10, (2)#12-G	MCC-B1	(E) HANDHOLE P6	E-04	TO 21-ME-01/02-ML. REUSE EXISTING CONDUIT
P21100B	3	(6)#10, (2)#12-G	MCC-B1	(E) HANDHOLE P6	E-04	TO 21-ME-03/04-ML. REUSE EXISTING CONDUIT
P21100C	3	(6)#10, (2)#12-G	MCC-B1	(E) HANDHOLE P6	E-04	TO 21-ME-05/06-ML. REUSE EXISTING CONDUIT
P21101	1	(3)#10, (1)#12-G	(E) HANDHOLE P6	21-ME-01-ML	21-E-01	FROM MCC-B1 VIA P21100A

Conduit Tag	Size [in.]	Fill	From	To	Dwg Ref.	Comments
P21102	1	(3)#10, (1)#12-G	(E) HANDHOLE P6	21-ME-02-ML	21-E-01	FROM MCC-B1 VIA P21100A
P21103	1	(3)#10, (1)#12-G	(E) HANDHOLE P6	21-ME-03-ML	21-E-01	FROM MCC-B1 VIA P21100B
P21104	1	(3)#10, (1)#12-G	(E) HANDHOLE P6	21-ME-04-ML	21-E-01	FROM MCC-B1 VIA P21100B
P21105	1	(3)#10, (1)#12-G	(E) HANDHOLE P6	21-ME-05-ML	21-E-01	FROM MCC-B1 VIA P21100C
P21106	1	(3)#10, (1)#12-G	(E) HANDHOLE P6	21-ME-06-ML	21-E-01	FROM MCC-B1 VIA P21100C
P21107	1 1/2	(3)#12, (12)#14-C, (2)#12-C, (1)#12-G, (4)#14-S	MCC-B1	21-ME-07-ML	21-E-01	POWER & CONTROL
P21108	1 1/2	(3)#12, (12)#14-C, (2)#12-C, (1)#12-G, (4)#14-S	MCC-B1	21-P-04-ML	21-E-01	POWER & CONTROL
P21109	1 1/2	(3)#12, (12)#14-C, (2)#12-C, (1)#12-G, (4)#14-S	MCC-B1	21-P-05-ML	21-E-01	POWER & CONTROL
P21120	3/4	(3)#12, (1)#12-G	DPB2	TERMINAL BOX	21-E-01	
P21121	3/4	(3)#12, (1)#12-G	TERMINAL BOX	21-V-02-AA	21-E-01	TO DPB2 VIA P21120
P21122	3/4	(3)#12, (1)#12-G	TERMINAL BOX	21-V-04-AA	21-E-01	TO DPB2 VIA P21120
P21123	3/4	(3)#12, (1)#12-G	TERMINAL BOX	21-V-06-AA	21-E-01	TO DPB2 VIA P21120
P21124	3/4	(3)#12, (1)#12-G	TERMINAL BOX	21-V-08-AA	21-E-01	TO DPB2 VIA P21120
PX21101	4	PULL ROPE	HH-P104	HH-P106	E-04	
S21000	2 1/2	(9)TSP-C	51-CP-01	AREA 21 ANALYZERS	21-E-01	
S21001	3/4	(1)TSP-C	CONDUIT S21000	21-AE/AIT-E10-1	21-E-01	FROM 51-CP-01 VIA S21000
S21002	3/4	(1)TSP-C	CONDUIT S21000	21-AE/AIT-E10-2	21-E-01	FROM 51-CP-01 VIA S21000
S21003	3/4	(1)TSP-C	CONDUIT S21000	21-AE/AIT-E10-3	21-E-01	FROM 51-CP-01 VIA S21000
S21004	3/4	(1)TSP-C	CONDUIT S21000	21-AE/AIT-E10-4	21-E-01	FROM 51-CP-01 VIA S21000
S21005	3/4	(1)TSP-C	CONDUIT S21000	21-AE/AIT-E10-5	21-E-01	FROM 51-CP-01 VIA S21000
S21020	3/4	(1)TSP-C	CONDUIT S21000	21-FE/FIT-E20	21-E-01	FROM 51-CP-01 VIA S21000
S21021	3/4	(1)TSP-C	CONDUIT S21000	21-FE/FIT-E21	21-E-01	FROM 51-CP-01 VIA S21000
S21022	3/4	(1)TSP-C	CONDUIT S21000	21-FE/FIT-E22	21-E-01	FROM 51-CP-01 VIA S21000
S21023	3/4	(1)TSP-C	CONDUIT S21000	21-FE/FIT-E23	21-E-01	FROM 51-CP-01 VIA S21000
S21101	2	(8)TSP-C	51-CP-01	AREA 21 MOVS	21-E-01	
S21121	1 1/4	(2)TSP-C	CONDUIT S21101	21-V-02-AA	21-E-01	FROM 51-CP-01 VIA S21101
S21122	1 1/4	(2)TSP-C	CONDUIT S21101	21-V-04-AA	21-E-01	FROM 51-CP-01 VIA S21101
S21123	1 1/4	(2)TSP-C	CONDUIT S21101	21-V-06-AA	21-E-01	FROM 51-CP-01 VIA S21101
S21124	1 1/4	(2)TSP-C	CONDUIT S21101	21-V-08-AA	21-E-01	FROM 51-CP-01 VIA S21101
X21101	2	PULL ROPE	HH-P104	HH-P106	E-04	
C22101	2	(24)#14-C, (8)#14-S	51-CP-01	AREA 22 MOVS	21-E-01	
C22121	1	(6)#14-C, (2)#14-S	CONDUIT C22101	22-V-02-AA	21-E-01	FROM 51-CP-01 VIA C22101
C22122	1	(6)#14-C, (2)#14-S	CONDUIT C22101	22-V-04-AA	21-E-01	FROM 51-CP-01 VIA C22101
C22123	1	(6)#14-C, (2)#14-S	CONDUIT C22101	22-V-06-AA	21-E-01	FROM 51-CP-01 VIA C22101
C22124	1	(6)#14-C, (2)#14-S	CONDUIT C22101	22-V-08-AA	21-E-01	FROM 51-CP-01 VIA C22101

Conduit Tag	Size [in.]	Fill	From	To	Dwg Ref.	Comments
EL22000	2	(18)#12, (9)#12-G	LP-B5U	AREA 22 INSTRUMENTS	22-E-01	
EL22001	3/4	(2)#12, (1)#12-G	CONDUIT EL22000	22-AE/AIT-E10-1	22-E-01	FROM 51-CP-01 VIA EL22000
EL22002	3/4	(2)#12, (1)#12-G	CONDUIT EL22000	22-AE/AIT-E10-2	22-E-01	FROM 51-CP-01 VIA EL22000
EL22003	3/4	(2)#12, (1)#12-G	CONDUIT EL22000	22-AE/AIT-E10-3	22-E-01	FROM 51-CP-01 VIA EL22000
EL22004	3/4	(2)#12, (1)#12-G	CONDUIT EL22000	22-AE/AIT-E10-4	22-E-01	FROM 51-CP-01 VIA EL22000
EL22005	3/4	(2)#12, (1)#12-G	CONDUIT EL22000	22-AE/AIT-E10-5	22-E-01	FROM 51-CP-01 VIA EL22000
EL22020	3/4	(2)#12, (1)#12-G	CONDUIT EL22000	22-FE/FIT-E20	22-E-01	FROM 51-CP-01 VIA EL22000
EL22021	3/4	(2)#12, (1)#12-G	CONDUIT EL22000	22-FE/FIT-E21	22-E-01	FROM 51-CP-01 VIA EL22000
EL22022	3/4	(2)#12, (1)#12-G	CONDUIT EL22000	22-FE/FIT-E22	22-E-01	FROM 51-CP-01 VIA EL22000
EL22023	3/4	(2)#12, (1)#12-G	CONDUIT EL22000	22-FE/FIT-E23	22-E-01	FROM 51-CP-01 VIA EL22000
L22110	3/4	(4)#12, (2)#12-G	LP-B5A	HH-P106	E-04	
L22111	3/4	(2)#12, (1)#12-G	HH-P106	OX DITCH 2 LTG; CKT 4	22-E-02	TO LP-B5A VIA LP22110
L22112	3/4	(2)#12, (1)#12-G	HH-P106	OX DITCH 2 RECEPTS; CKT 5	22-E-02	TO LP-B5A VIA LP22110
L22160	3/4	(6)#12, (3)#12-G	LP-B5B	HH-P106	E-04	
L22161	3/4	(2)#12, (1)#12-G	HH-P106	OX DITCH 2 LTG; CKT 3	22-E-02	TO LP-B5B VIA LP22160
L22162	3/4	(2)#12, (1)#12-G	HH-P106	OX DITCH 2 LTG; CKT 4	22-E-02	TO LP-B5B VIA LP22160
L22163	3/4	(2)#12, (1)#12-G	HH-P106	OX DITCH 2 RECEPTS; CKT 5	22-E-02	TO LP-B5B VIA LP22160
N22101	1	(1) 3/C RS-485	51-CP-01	22-ME-01-ML	22-E-01	
N22102	1	(1) 3/C RS-485	22-ME-01-ML	22-ME-02-ML	22-E-01	
N22103	1	(1) 3/C RS-485	22-ME-02-ML	22-ME-03-ML	22-E-01	
N22104	1	(1) 3/C RS-485	22-ME-03-ML	22-ME-04-ML	22-E-01	
N22105	1	(1) 3/C RS-485	22-ME-04-ML	22-ME-05-ML	22-E-01	
N22106	1	(1) 3/C RS-485	22-ME-05-ML	22-ME-06-ML	22-E-01	
P22100A	3	(6)#10, (2)#12-G	MCC-B1	(E) HANDHOLE P4	E-04	TO 22-ME-01/02-ML. REUSE EXISTING CONDUIT
P22100B	3	(6)#10, (2)#12-G	MCC-B1	(E) HANDHOLE P4	E-04	TO 22-ME-03/04-ML. REUSE EXISTING CONDUIT
P22100C	3	(6)#10, (2)#12-G	MCC-B1	(E) HANDHOLE P4	E-04	TO 22-ME-05/06-ML. REUSE EXISTING CONDUIT
P22101	1	(3)#10, (1)#12-G	(E) HANDHOLE P4	22-ME-01-ML	22-E-01	FROM MCC-B1 VIA P22100A
P22102	1	(3)#10, (1)#12-G	(E) HANDHOLE P4	22-ME-02-ML	22-E-01	FROM MCC-B1 VIA P22100A
P22103	1	(3)#10, (1)#12-G	(E) HANDHOLE P4	22-ME-03-ML	22-E-01	FROM MCC-B1 VIA P22100B
P22104	1	(3)#10, (1)#12-G	(E) HANDHOLE P4	22-ME-04-ML	22-E-01	FROM MCC-B1 VIA P22100B
P22105	1	(3)#10, (1)#12-G	(E) HANDHOLE P4	22-ME-05-ML	22-E-01	FROM MCC-B1 VIA P22100C
P22106	1	(3)#10, (1)#12-G	(E) HANDHOLE P4	22-ME-06-ML	22-E-01	FROM MCC-B1 VIA P22100C
P22107	1 1/2	(3)#12, (12)#14-C, (2)#12-C, (1)#12-G, (4)#14-S	MCC-B1	22-ME-07-ML	22-E-01	POWER & CONTROL
P22108	1 1/2	(3)#12, (12)#14-C, (2)#12-C, (1)#12-G, (4)#14-S	MCC-B1	22-P-04-ML	22-E-01	POWER & CONTROL

Conduit Tag	Size [in.]	Fill	From	To	Dwg Ref.	Comments
P22109	1 1/2	(3)#12, (12)#14-C, (2)#12-C, (1)#12-G, (4)#14-S	MCC-B1	22-P-05-ML	22-E-01	POWER & CONTROL
P22120	3/4	(3)#12, (1)#12-G	DPB2	TERMINAL BOX	22-E-01	
P22121	3/4	(3)#12, (1)#12-G	TERMINAL BOX	22-V-02-AA	22-E-01	TO DPB2 VIA P22120
P22122	3/4	(3)#12, (1)#12-G	TERMINAL BOX	22-V-04-AA	22-E-01	TO DPB2 VIA P22120
P22123	3/4	(3)#12, (1)#12-G	TERMINAL BOX	22-V-06-AA	22-E-01	TO DPB2 VIA P22120
P22124	3/4	(3)#12, (1)#12-G	TERMINAL BOX	22-V-08-AA	22-E-01	TO DPB2 VIA P22120
PX22101	4	PULL ROPE	HH-P104	HH-P106	E-04	
S22000	2 1/2	(9)TSP-C	51-CP-01	AREA 22 ANALYZERS	22-E-01	
S22001	3/4	(1)TSP-C	CONDUIT S22000	22-AE/AIT-E10-1	22-E-01	FROM 51-CP-01 VIA S22000
S22002	3/4	(1)TSP-C	CONDUIT S22000	22-AE/AIT-E10-2	22-E-01	FROM 51-CP-01 VIA S22000
S22003	3/4	(1)TSP-C	CONDUIT S22000	22-AE/AIT-E10-3	22-E-01	FROM 51-CP-01 VIA S22000
S22004	3/4	(1)TSP-C	CONDUIT S22000	22-AE/AIT-E10-4	22-E-01	FROM 51-CP-01 VIA S22000
S22005	3/4	(1)TSP-C	CONDUIT S22000	22-AE/AIT-E10-5	22-E-01	FROM 51-CP-01 VIA S22000
S22020	3/4	(1)TSP-C	CONDUIT S22000	22-FE/FIT-E20	22-E-01	FROM 51-CP-01 VIA S22000
S22021	3/4	(1)TSP-C	CONDUIT S22000	22-FE/FIT-E21	22-E-01	FROM 51-CP-01 VIA S22000
S22022	3/4	(1)TSP-C	CONDUIT S22000	22-FE/FIT-E22	22-E-01	FROM 51-CP-01 VIA S22000
S22023	3/4	(1)TSP-C	CONDUIT S22000	22-FE/FIT-E23	22-E-01	FROM 51-CP-01 VIA S22000
S22101	2	(8)TSP-C	51-CP-01	AREA 22 MOVS	22-E-01	
S22121	1 1/4	(2)TSP-C	CONDUIT S22101	22-V-02-AA	22-E-01	FROM 51-CP-01 VIA S22101
S22122	1 1/4	(2)TSP-C	CONDUIT S22101	22-V-04-AA	22-E-01	FROM 51-CP-01 VIA S22101
S22123	1 1/4	(2)TSP-C	CONDUIT S22101	22-V-06-AA	22-E-01	FROM 51-CP-01 VIA S22101
S22124	1 1/4	(2)TSP-C	CONDUIT S22101	22-V-08-AA	22-E-01	FROM 51-CP-01 VIA S22101
X22101	2	PULL ROPE	HH-P104	HH-P106	E-04	
C23000	3	(56)#14-C, (8)#14-S	27-MCP-01	AREA 23 MOVS	23-E-01	VIA PB-23000C
C23111	1 1/4	(14)#14-C, (2)#14-S	CONDUIT C23000	23-V-02-AA	23-E-01	FROM 27-MCP-01 VIA C23000B
C23112	1 1/4	(14)#14-C, (2)#14-S	CONDUIT C23000	23-V-04-AA	23-E-01	FROM 27-MCP-01 VIA C23000B
C23113	1 1/4	(14)#14-C, (2)#14-S	CONDUIT C23000	23-V-06-AA	23-E-01	FROM 27-MCP-01 VIA C23000B
C23114	1 1/4	(14)#14-C, (2)#14-S	CONDUIT C23000	23-V-08-AA	23-E-01	FROM 27-MCP-01 VIA C23000B
EL23000	2	(18)#12, (9)#12-G	LP-D2U	AREA 23 INSTRUMENTS	23-E-01	VIA PB-23000L
EL23001	3/4	(2)#12, (1)#12-G	CONDUIT EL23000	23-AIT-E10-1	23-E-01	FROM LP-D2U VIA EL23000
EL23002	3/4	(2)#12, (1)#12-G	CONDUIT EL23000	23-AIT-E10-2	23-E-01	FROM LP-D2U VIA EL23000
EL23003	3/4	(2)#12, (1)#12-G	CONDUIT EL23000	23-AIT-E10-3	23-E-01	FROM LP-D2U VIA EL23000
EL23004	3/4	(2)#12, (1)#12-G	CONDUIT EL23000	23-AIT-E10-4	23-E-01	FROM LP-D2U VIA EL23000
EL23005	3/4	(2)#12, (1)#12-G	CONDUIT EL23000	23-AIT-E10-5	23-E-01	FROM LP-D2U VIA EL23000
EL23020	3/4	(2)#12, (1)#12-G	CONDUIT EL23000	23-FE/FIT-E20	23-E-01	FROM LP-D2U VIA EL23000
EL23021	3/4	(2)#12, (1)#12-G	CONDUIT EL23000	23-FE/FIT-E21	23-E-01	FROM LP-D2U VIA EL23000

Conduit Tag	Size [in.]	Fill	From	To	Dwg Ref.	Comments
EL23022	3/4	(2)#12, (1)#12-G	CONDUIT EL23000	23-FE/FIT-E22	23-E-01	FROM LP-D2U VIA EL23000
EL23023	3/4	(2)#12, (1)#12-G	CONDUIT EL23000	23-FE/FIT-E23	23-E-01	FROM LP-D2U VIA EL23000
L23101	3/4	(2)#10, (1)#10-G	LP-D2A	SITE LIGHTING; CKT 25	E-05	
L23102	3/4	(2)#10, (1)#10-G	LP-D2B	SITE LIGHTING; CKT 21	E-05	
L23110	1	(8)#12, (4)#12-G	LP-D2A	PB-23000L	23-E-01	
L23111	3/4	(2)#12, (1)#12-G	PB-23000L	AER BASINS LTG; CKT 1	23-E-02	TO LP-D2A VIA L23110
L23112	3/4	(2)#12, (1)#12-G	PB-23000L	AER BASINS RECEPTS; CKT 2	23-E-02	TO LP-D2A VIA L23110
L23113	3/4	(2)#12, (1)#12-G	PB-23000L	AER BASINS LTG; CKT 14	23-E-02	TO LP-D2A VIA L23110
L23114	3/4	(2)#12, (1)#12-G	PB-23000L	AER BASINS LOWER LTG; CKT 23	23-E-02	TO LP-D2A VIA L23110
L23160	3/4	(6)#12, (3)#12-G	LP-D2B	PB-23000L	23-E-01	
L23161	3/4	(2)#12, (1)#12-G	PB-23000L	AER BASINS LTG; CKT 1	23-E-02	TO LP-D2B VIA L23160
L23162	3/4	(2)#12, (1)#12-G	PB-23000L	AER BASINS RECEPTS; CKT 2	23-E-02	TO LP-D2B VIA L23160
L23163	3/4	(2)#12, (1)#12-G	PB-23000L	AER BASINS LOWER LTG; CKT 18	23-E-02	TO LP-D2B VIA L23160
N23101	1	(1) 3/C RS-485	23-ME-02-ML	23-ME-01-ML	23-E-01	
N23102	1	(1) 3/C RS-485	23-ME-03-ML	23-ME-02-ML	23-E-01	
N23103	1	(1) 3/C RS-485	23-ME-04-ML	23-ME-03-ML	23-E-01	
N23104	1	(1) 3/C RS-485	27-CP-01	23-ME-04-ML	23-E-01	
P23101	3/4	(3)#12, (1)#12-G	MCC D2A	23-ME-01-ML	23-E-01	
P23102	3/4	(3)#12, (1)#12-G	MCC D2A	23-ME-02-ML	23-E-01	
P23103	3/4	(3)#12, (1)#12-G	MCC D2A	23-ME-03-ML	23-E-01	
P23104	3/4	(3)#12, (1)#12-G	MCC D2A	23-ME-04-ML	23-E-01	
P23105	1 1/2	(3)#12, (12)#14-C, (2)#12-C, (1)#12-G, (4)#14-S	MCC D2A	23-ME-05-ML	23-E-01	
P23106	1 1/2	(3)#12, (12)#14-C, (2)#12-C, (1)#12-G, (4)#14-S	MCC D2A	23-P-01-ML	23-E-01	
P23110	3/4	(3)#12, (1)#12-G	MCC D2A	TERMINAL BOX	23-E-01	
P23111	3/4	(3)#12, (1)#12-G	TERMINAL BOX	23-V-02-AA	23-E-01	TO MCC D2A VIA P23110
P23112	3/4	(3)#12, (1)#12-G	TERMINAL BOX	23-V-04-AA	23-E-01	TO MCC D2A VIA P23110
P23113	3/4	(3)#12, (1)#12-G	TERMINAL BOX	23-V-06-AA	23-E-01	TO MCC D2A VIA P23110
P23114	3/4	(3)#12, (1)#12-G	TERMINAL BOX	23-V-08-AA	23-E-01	TO MCC D2A VIA P23110
S23000A	2	(5)TSP-C	27-CP-01	AREA 23 ANALYZERS	23-E-01	VIA PB-23000S
S23000B	2	(8)TSP-C	27-MCP-01	AREA 23 FLOWMETERS & MOVS	23-E-01	VIA PB-23000S
S23001	3/4	(1)TSP-C	CONDUIT S23000A	23-AIT-E10-1	23-E-01	FROM 27-CP-01 VIA S23000A
S23002	3/4	(1)TSP-C	CONDUIT S23000A	23-AIT-E10-2	23-E-01	FROM 27-CP-01 VIA S23000A
S23003	3/4	(1)TSP-C	CONDUIT S23000A	23-AIT-E10-3	23-E-01	FROM 27-CP-01 VIA S23000A
S23004	3/4	(1)TSP-C	CONDUIT S23000A	23-AIT-E10-4	23-E-01	FROM 27-CP-01 VIA S23000A
S23005	3/4	(1)TSP-C	CONDUIT S23000A	23-AIT-E10-5	23-E-01	FROM 27-CP-01 VIA S23000A

Conduit Tag	Size [in.]	Fill	From	To	Dwg Ref.	Comments
S23020	3/4	(1)TSP-C	CONDUIT S23000B	23-FE/FIT-E20	23-E-01	FROM 27-MCP-01 VIA S23000B
S23021	3/4	(1)TSP-C	CONDUIT S23000B	23-FE/FIT-E21	23-E-01	FROM 27-MCP-01 VIA S23000B
S23022	3/4	(1)TSP-C	CONDUIT S23000B	23-FE/FIT-E22	23-E-01	FROM 27-MCP-01 VIA S23000B
S23023	3/4	(1)TSP-C	CONDUIT S23000B	23-FE/FIT-E23	23-E-01	FROM 27-MCP-01 VIA S23000B
S23111	3/4	(1)TSP-C	CONDUIT S23000B	23-V-02-AA	23-E-01	FROM 27-MCP-01 VIA S23000B
S23112	3/4	(1)TSP-C	CONDUIT S23000B	23-V-04-AA	23-E-01	FROM 27-MCP-01 VIA S23000B
S23113	3/4	(1)TSP-C	CONDUIT S23000B	23-V-06-AA	23-E-01	FROM 27-MCP-01 VIA S23000B
S23114	3/4	(1)TSP-C	CONDUIT S23000B	23-V-08-AA	23-E-01	FROM 27-MCP-01 VIA S23000B
C24000	3	(56)#14-C, (8)#14-S	27-MCP-01	AREA 24 MOVS	23-E-01	VIA PB-23000C
C24111	1 1/4	(14)#14-C, (2)#14-S	CONDUIT C24000	24-V-02-AA	23-E-01	FROM 27-MCP-01 VIA C24000B
C24112	1 1/4	(14)#14-C, (2)#14-S	CONDUIT C24000	24-V-04-AA	23-E-01	FROM 27-MCP-01 VIA C24000B
C24113	1 1/4	(14)#14-C, (2)#14-S	CONDUIT C24000	24-V-06-AA	23-E-01	FROM 27-MCP-01 VIA C24000B
C24114	1 1/4	(14)#14-C, (2)#14-S	CONDUIT C24000	24-V-08-AA	23-E-01	FROM 27-MCP-01 VIA C24000B
EL24000	2	(18)#12, (9)#12-G	LP-D2U	AREA 24 INSTRUMENTS	23-E-01	VIA PB-23000L
EL24001	3/4	(2)#12, (1)#12-G	CONDUIT EL24000	24-AIT-E10-1	23-E-01	FROM LP-D2U VIA EL24000
EL24002	3/4	(2)#12, (1)#12-G	CONDUIT EL24000	24-AIT-E10-2	23-E-01	FROM LP-D2U VIA EL24000
EL24003	3/4	(2)#12, (1)#12-G	CONDUIT EL24000	24-AIT-E10-3	23-E-01	FROM LP-D2U VIA EL24000
EL24004	3/4	(2)#12, (1)#12-G	CONDUIT EL24000	24-AIT-E10-4	23-E-01	FROM LP-D2U VIA EL24000
EL24005	3/4	(2)#12, (1)#12-G	CONDUIT EL24000	24-AIT-E10-5	23-E-01	FROM LP-D2U VIA EL24000
EL24020	3/4	(2)#12, (1)#12-G	CONDUIT EL24000	24-FE/FIT-E20	23-E-01	FROM LP-D2U VIA EL24000
EL24021	3/4	(2)#12, (1)#12-G	CONDUIT EL24000	24-FE/FIT-E21	23-E-01	FROM LP-D2U VIA EL24000
EL24022	3/4	(2)#12, (1)#12-G	CONDUIT EL24000	24-FE/FIT-E22	23-E-01	FROM LP-D2U VIA EL24000
EL24023	3/4	(2)#12, (1)#12-G	CONDUIT EL24000	24-FE/FIT-E23	23-E-01	FROM LP-D2U VIA EL24000
N24101	1	(1) 3/C RS-485	24-ME-02-ML	24-ME-01-ML	23-E-01	
N24102	1	(1) 3/C RS-485	24-ME-03-ML	24-ME-02-ML	23-E-01	
N24103	1	(1) 3/C RS-485	24-ME-04-ML	24-ME-03-ML	23-E-01	
N24104	1	(1) 3/C RS-485	27-CP-01	24-ME-04-ML	23-E-01	
P24101	3/4	(3)#12, (1)#12-G	MCC D2B	24-ME-01-ML	23-E-01	
P24102	3/4	(3)#12, (1)#12-G	MCC D2B	24-ME-02-ML	23-E-01	
P24103	3/4	(3)#12, (1)#12-G	MCC D2B	24-ME-03-ML	23-E-01	
P24104	3/4	(3)#12, (1)#12-G	MCC D2B	24-ME-04-ML	23-E-01	
P24105	1 1/2	(3)#12, (12)#14-C, (2)#12-C, (1)#12-G, (4)#14-S	MCC D2B	24-ME-05-ML	23-E-01	
P24106	1 1/2	(3)#12, (12)#14-C, (2)#12-C, (1)#12-G, (4)#14-S	MCC D2B	24-P-01-ML	23-E-01	
P24110	3/4	(3)#12, (1)#12-G	MCC D2B	TERMINAL BOX	23-E-01	
P24111	3/4	(3)#12, (1)#12-G	TERMINAL BOX	24-V-02-AA	23-E-01	TO MCC D2B VIA P24110

Conduit Tag	Size [in.]	Fill	From	To	Dwg Ref.	Comments
P24112	3/4	(3)#12, (1)#12-G	TERMINAL BOX	24-V-04-AA	23-E-01	TO MCC D2B VIA P24110
P24113	3/4	(3)#12, (1)#12-G	TERMINAL BOX	24-V-06-AA	23-E-01	TO MCC D2B VIA P24110
P24114	3/4	(3)#12, (1)#12-G	TERMINAL BOX	24-V-08-AA	23-E-01	TO MCC D2B VIA P24110
S24000A	2	(5)TSP-C	27-CP-01	AREA 24 ANALYZERS	23-E-01	VIA PB-23000S
S24000B	2	(8)TSP-C	27-MCP-01	AREA 24 FLOWMETERS & MOVS	23-E-01	VIA PB-23000S
S24001	3/4	(1)TSP-C	CONDUIT S24000A	24-AIT-E10-1	23-E-01	FROM 27-CP-01 VIA S24000A
S24002	3/4	(1)TSP-C	CONDUIT S24000A	24-AIT-E10-2	23-E-01	FROM 27-CP-01 VIA S24000A
S24003	3/4	(1)TSP-C	CONDUIT S24000A	24-AIT-E10-3	23-E-01	FROM 27-CP-01 VIA S24000A
S24004	3/4	(1)TSP-C	CONDUIT S24000A	24-AIT-E10-4	23-E-01	FROM 27-CP-01 VIA S24000A
S24005	3/4	(1)TSP-C	CONDUIT S24000A	24-AIT-E10-5	23-E-01	FROM 27-CP-01 VIA S24000A
S24020	3/4	(1)TSP-C	CONDUIT S24000B	24-FE/FIT-E20	23-E-01	FROM 27-MCP-01 VIA S24000B
S24021	3/4	(1)TSP-C	CONDUIT S24000B	24-FE/FIT-E21	23-E-01	FROM 27-MCP-01 VIA S24000B
S24022	3/4	(1)TSP-C	CONDUIT S24000B	24-FE/FIT-E22	23-E-01	FROM 27-MCP-01 VIA S24000B
S24023	3/4	(1)TSP-C	CONDUIT S24000B	24-FE/FIT-E23	23-E-01	FROM 27-MCP-01 VIA S24000B
S24111	3/4	(1)TSP-C	CONDUIT S24000B	24-V-02-AA	23-E-01	FROM 27-MCP-01 VIA S24000B
S24112	3/4	(1)TSP-C	CONDUIT S24000B	24-V-04-AA	23-E-01	FROM 27-MCP-01 VIA S24000B
S24113	3/4	(1)TSP-C	CONDUIT S24000B	24-V-06-AA	23-E-01	FROM 27-MCP-01 VIA S24000B
S24114	3/4	(1)TSP-C	CONDUIT S24000B	24-V-08-AA	23-E-01	FROM 27-MCP-01 VIA S24000B
C27100	2	(24)#14-C, (8)#14-S	27-MCP-01	AREA 27 BLOWER RVSS	27-E-01	
C27101	1	(6)#14-C, (2)#14-S	CONDUIT C27100	27-RVSS-01-AA	27-E-01	FROM 27-MCP-01 VIA C27100
C27102	1	(6)#14-C, (2)#14-S	CONDUIT C27100	27-RVSS-03-AA	27-E-01	FROM 27-MCP-01 VIA C27100
C27105	3/4	(10)#14-C	BLOWER RM THERMOSTAT	27-ME-01-A	27-E-02	
C27151	1	(6)#14-C, (2)#14-S	CONDUIT C27100	27-RVSS-02-AA	27-E-01	FROM 27-MCP-01 VIA C27100
C27152	1	(6)#14-C, (2)#14-S	CONDUIT C27100	27-RVSS-04-AA	27-E-01	FROM 27-MCP-01 VIA C27100
C27200A	4	SEE COMMENT	27-MCP-01	AREA 27 BLOWER LCPS	27-E-02	FINAL CONDUIT FILL AS SPECIFIED BY BLOWER SYSTEM SUPPLIER
C27200B	4	SEE COMMENT	27-MCP-01	AREA 27 BLOWER LCPS	27-E-02	FINAL CONDUIT FILL AS SPECIFIED BY BLOWER SYSTEM SUPPLIER
C27201A	2	SEE COMMENT	CONDUIT C27200A	27-LCP-01	27-E-02	FROM 27-MCP-01 VIA C27200A; FINAL CONDUIT FILL AS SPECIFIED BY BLOWER SYSTEM SUPPLIER
C27201B	2	SEE COMMENT	CONDUIT C27200B	27-LCP-01	27-E-02	FROM 27-MCP-01 VIA C27200B; FINAL CONDUIT FILL AS SPECIFIED BY BLOWER SYSTEM SUPPLIER

Conduit Tag	Size [in.]	Fill	From	To	Dwg Ref.	Comments
C27202A	2	SEE COMMENT	CONDUIT C27200A	27-LCP-02	27-E-02	FROM 27-MCP-01 VIA C27200A; FINAL CONDUIT FILL AS SPECIFIED BY BLOWER SYSTEM SUPPLIER
C27202B	2	SEE COMMENT	CONDUIT C27200B	27-LCP-02	27-E-02	FROM 27-MCP-01 VIA C27200B; FINAL CONDUIT FILL AS SPECIFIED BY BLOWER SYSTEM SUPPLIER
C27203A	2	SEE COMMENT	CONDUIT C27200A	27-LCP-03	27-E-02	FROM 27-MCP-01 VIA C27200A; FINAL CONDUIT FILL AS SPECIFIED BY BLOWER SYSTEM SUPPLIER
C27203B	2	SEE COMMENT	CONDUIT C27200B	27-LCP-03	27-E-02	FROM 27-MCP-01 VIA C27200B; FINAL CONDUIT FILL AS SPECIFIED BY BLOWER SYSTEM SUPPLIER
C27204A	2	SEE COMMENT	CONDUIT C27200A	27-LCP-04	27-E-02	FROM 27-MCP-01 VIA C27200A; FINAL CONDUIT FILL AS SPECIFIED BY BLOWER SYSTEM SUPPLIER
C27204B	2	SEE COMMENT	CONDUIT C27200B	27-LCP-04	27-E-02	FROM 27-MCP-01 VIA C27200B; FINAL CONDUIT FILL AS SPECIFIED BY BLOWER SYSTEM SUPPLIER
CX27103	1	PULL ROPE	CONDUIT C27100	27-RVSS-05-AA (FUTURE)	27-E-01	FROM 27-MCP-01 VIA C27100
CX27205A	2	PULL ROPE	CONDUIT C27200A	27-LCP-05 (FUTURE)	27-E-02	FROM 27-MCP-01 VIA C27200A; FINAL CONDUIT FILL AS SPECIFIED BY BLOWER SYSTEM SUPPLIER
CX27205B	2	PULL ROPE	CONDUIT C27200B	27-LCP-05 (FUTURE)	27-E-02	FROM 27-MCP-01 VIA C27200B; FINAL CONDUIT FILL AS SPECIFIED BY BLOWER SYSTEM SUPPLIER
EL27001	3/4	(2)#12, (1)#12-G	LP-D2U	27-CP-01	27-E-01	
EL27002	3/4	(2)#12, (1)#12-G	LP-D2U	27-MCP-01	27-E-01	
EL27201	3/4	(2)#10, (1)#10-G	LP-D2U	27-LCP-01	27-E-02	
EL27202	3/4	(2)#10, (1)#10-G	LP-D2U	27-LCP-02	27-E-02	
EL27203	3/4	(2)#10, (1)#10-G	LP-D2U	27-LCP-03	27-E-02	
EL27204	3/4	(2)#10, (1)#10-G	LP-D2U	27-LCP-04	27-E-02	
ELX27205	3/4	PULL ROPE	LP-D2U	27-LCP-05 (FUTURE)	27-E-02	
FO27001	2	(3) 12 FO CABLES	(E) 16-CP-01	27-CP-01	27-E-01	
L27001	3/4	(2)#12, (1)#12-G	LP-D2A	27-CP-01	27-E-01	
L27002	3/4	(2)#12, (1)#12-G	LP-D2A	27-MCP-01	27-E-01	
L27101	3/4	(2)#12, (1)#12-G	LP-D2A	OX DITCH 2 WALKWAY LTG	22-E-02	
L27110	3	(3)#4/0, (1)#4/0-N, (1)#4-G	XFMR-D2A	LP-D2A	27-E-01	

Conduit Tag	Size [in.]	Fill	From	To	Dwg Ref.	Comments
L27115	1 1/2	(3)#2, (1)#8-G	LP-D2A	MTS-D2U	27-E-01	
L27160	3	(3)#4/0, (1)#4/0-N, (1)#4-G	XFMR-D2B	LP-D2B	27-E-01	
L27165	1 1/2	(3)#2, (1)#8-G	LP-D2B	MTS-D2U	27-E-01	
L27170	1 1/2	(3)#2, (1)#8-G	MTS-D2U	UPS-D2U	27-E-01	
L27201	3/4	(2)#10, (1)#10-G	LP-D2A	27-LCP-01	27-E-02	
L27202	3/4	(2)#10, (1)#10-G	LP-D2B	27-LCP-02	27-E-02	
L27203	3/4	(2)#10, (1)#10-G	LP-D2A	27-LCP-03	27-E-02	
L27204	3/4	(2)#10, (1)#10-G	LP-D2B	27-LCP-04	27-E-02	
L27301	3/4	(2)#12, (1)#12-G	LP-D2A	27-F-03-A	27-E-01	
L27302	3/4	(2)#12, (1)#12-G	LP-D2B	27-F-04-A	27-E-01	
LX27205	3/4	PULL ROPE	LP-D2B	27-LCP-05 (FUTURE)	27-E-02	
N27001	3/4	(1)Cat6-C	27-MCP-01	27-CP-01	27-E-01	
N27101	1 1/4	(2)Cat6-C	DPD2	27-CP-01	27-E-01	
N27200	1 1/4	(4)Cat6-C	27-MCP-01	AREA 27 BLOWER LCPS	27-E-02	
N27201	3/4	(1)Cat6-C	CONDUIT N27200	27-LCP-01	27-E-02	FROM 27-MCP-01 VIA N27200
N27202	3/4	(1)Cat6-C	CONDUIT N27200	27-LCP-02	27-E-02	FROM 27-MCP-01 VIA N27200
N27203	3/4	(1)Cat6-C	CONDUIT N27200	27-LCP-03	27-E-02	FROM 27-MCP-01 VIA N27200
N27204	3/4	(1)Cat6-C	CONDUIT N27200	27-LCP-04	27-E-02	FROM 27-MCP-01 VIA N27200
NX27205	3/4	(1)Cat6-C	CONDUIT N27200	27-LCP-05 (FUTURE)	27-E-02	FROM 27-MCP-01 VIA N27200
P27001A	4	(3)#500KCMIL, (1)#250KCMIL-G	SWGR DA	DPD2A	27-E-01	
P27001B	4	(3)#500KCMIL, (1)#250KCMIL-G	SWGR DA	DPD2A	27-E-01	
P27001C	4	(3)#500KCMIL, (1)#250KCMIL-G	SWGR DA	DPD2A	27-E-01	
P27010A	2 1/2	(3)#4/0, (1)#2-G	DPD2A	MCC D2A	27-E-01	
P27010B	2 1/2	(3)#4/0, (1)#2-G	DPD2A	MCC D2A	27-E-01	
P27051A	4	(3)#500KCMIL, (1)#250KCMIL-G	SWGR DB	DPD2B	27-E-01	
P27051B	4	(3)#500KCMIL, (1)#250KCMIL-G	SWGR DB	DPD2B	27-E-01	
P27051C	4	(3)#500KCMIL, (1)#250KCMIL-G	SWGR DB	DPD2B	27-E-01	
P27060A	2 1/2	(3)#4/0, (1)#2-G	DPD2B	MCC D2B	27-E-01	
P27060B	2 1/2	(3)#4/0, (1)#2-G	DPD2B	MCC D2B	27-E-01	
P27101	3	(3)#350KCMIL, (1)#3-G	DPD2A	27-RVSS-01-AA	27-E-01	
P27101A	3	(3)#350KCMIL, (1)#3-G	27-RVSS-01-AA	27-B-01-AA	27-E-02	
P27102	3	(3)#350KCMIL, (1)#3-G	DPD2A	27-RVSS-03-AA	27-E-01	
P27102A	3	(3)#350KCMIL, (1)#3-G	27-RVSS-03-AA	27-B-03-AA	27-E-02	
P27105	1 1/4	(3)#6, (1)#10-G	MCC D2A	27-ME-01-A	27-E-02	

Conduit Tag	Size [in.]	Fill	From	To	Dwg Ref.	Comments
P27110	2	(3)#1/0, (1)#6-G	MCC D2A	XFMR-D2A	27-E-01	
P27120	3/4	(3)#12, (1)#12-G	MCC-D2A	27-F-01-A	27-E-01	
P27151	3	(3)#350KCMIL, (1)#3-G	DPD2B	27-RVSS-02-AA	27-E-01	
P27151A	3	(3)#350KCMIL, (1)#3-G	27-RVSS-02-AA	27-B-02-AA	27-E-02	
P27152	3	(3)#350KCMIL, (1)#3-G	DPD2B	27-RVSS-04-AA	27-E-01	
P27152A	3	(3)#350KCMIL, (1)#3-G	27-RVSS-04-AA	27-B-04-AA	27-E-02	
P27155	3/4	(2)#12, (1)#12-G	MCC D2B	27-ME-02-A	27-E-01	
P27160	2	(3)#1/0, (1)#6-G	MCC D2B	XFMR-D2B	27-E-01	
P27170	3/4	(3)#12, (1)#12-G	MCC-D2B	27-F-02-A	27-E-01	
P27213	1 1/4	(3)#10, (6)#14-C, (1)#10-G	27-LCP-01	27-V-13-AA	27-E-02	FINAL CONDUIT FILL AS SPECIFIED BY BLOWER SYSTEM SUPPLIER
P27214	1 1/4	(3)#10, (6)#14-C, (1)#10-G	27-LCP-01	27-V-14-AA	27-E-02	FINAL CONDUIT FILL AS SPECIFIED BY BLOWER SYSTEM SUPPLIER
P27223	1 1/4	(3)#10, (6)#14-C, (1)#10-G	27-LCP-02	27-V-23-AA	27-E-02	FINAL CONDUIT FILL AS SPECIFIED BY BLOWER SYSTEM SUPPLIER
P27224	1 1/4	(3)#10, (6)#14-C, (1)#10-G	27-LCP-02	27-V-24-AA	27-E-02	FINAL CONDUIT FILL AS SPECIFIED BY BLOWER SYSTEM SUPPLIER
P27233	1 1/4	(3)#10, (6)#14-C, (1)#10-G	27-LCP-03	27-V-33-AA	27-E-02	FINAL CONDUIT FILL AS SPECIFIED BY BLOWER SYSTEM SUPPLIER
P27234	1 1/4	(3)#10, (6)#14-C, (1)#10-G	27-LCP-03	27-V-34-AA	27-E-02	FINAL CONDUIT FILL AS SPECIFIED BY BLOWER SYSTEM SUPPLIER
P27243	1 1/4	(3)#10, (6)#14-C, (1)#10-G	27-LCP-04	27-V-43-AA	27-E-02	FINAL CONDUIT FILL AS SPECIFIED BY BLOWER SYSTEM SUPPLIER
P27244	1 1/4	(3)#10, (6)#14-C, (1)#10-G	27-LCP-04	27-V-44-AA	27-E-02	FINAL CONDUIT FILL AS SPECIFIED BY BLOWER SYSTEM SUPPLIER
PX27103	3	PULL ROPE	DPD2A	FUTURE 27-RVSS-05-AA	27-E-01	
PX27103A	3	PULL ROPE	FUTURE 27-RVSS-05-AA	FUTURE 27-B-05-AA	27-E-02	
S27100	1 1/2	(4)TSP-C	27-MCP-01	AREA 27 BLOWER RVSS	27-E-02	
S27101	3/4	(1)TSP-C	CONDUIT S27100	27-RVSS-01-AA	27-E-02	FROM 27-MCP-01 VIA S27100
S27102	3/4	(1)TSP-C	CONDUIT S27100	27-RVSS-03-AA	27-E-02	FROM 27-MCP-01 VIA S27100
S27151	3/4	(1)TSP-C	CONDUIT S27100	27-RVSS-02-AA	27-E-02	FROM 27-MCP-01 VIA S27100
S27152	3/4	(1)TSP-C	CONDUIT S27100	27-RVSS-04-AA	27-E-02	FROM 27-MCP-01 VIA S27100
S27160	3/4	(1)TSP-C	27-MCP-01	27-PIT-E60	27-E-02	
S27217	3/4	(1)TSP-C	27-LCP-01	27-TT-E17	27-E-02	FINAL CONDUIT FILL AS SPECIFIED BY BLOWER SYSTEM SUPPLIER

Conduit Tag	Size [in.]	Fill	From	To	Dwg Ref.	Comments
S27227	3/4	(1)TSP-C	27-LCP-02	27-TT-E27	27-E-02	FINAL CONDUIT FILL AS SPECIFIED BY BLOWER SYSTEM SUPPLIER
S27237	3/4	(1)TSP-C	27-LCP-03	27-TT-E37	27-E-02	FINAL CONDUIT FILL AS SPECIFIED BY BLOWER SYSTEM SUPPLIER
S27247	3/4	(1)TSP-C	27-LCP-04	27-TT-E47	27-E-02	FINAL CONDUIT FILL AS SPECIFIED BY BLOWER SYSTEM SUPPLIER
SX27103	3/4	PULL ROPE	CONDUIT S27100	27-RVSS-05-AA (FUTURE)	27-E-02	FROM 27-MCP-01 VIA S27100
C34101	3/4	(2)#12-C	34-CP-01	34-SV-01-UW	34-E-01	
FO34001	1	(1) 12 FO CABLE	27-CP-01	34-CP-01	34-E-01	
L34101	3/4	(2)#10, (1)#10-G	LP-D3A	SITE LIGHTING; CKT 13	E-05	
L34102	3/4	(2)#10, (1)#10-G	LP-D3B	SITE LIGHTING; CKT 2	E-05	
L34110	1	(4)#12, (2)#12-G	LP-D3A	HH-P36	34-E-01	
L34111	3/4	(2)#12, (1)#12-G	HH-P36	SEC CLARIFIER #3 LTG;CKT 1	34-E-02	TO LP-D3A VIA L34110
L34112	3/4	(2)#12, (1)#12-G	HH-P36	SEC CLAR #3 RECPT;CKT 7	34-E-02	TO LP-D3A VIA L34110
L34120	1	(4)#12, (2)#12-G	LP-D3B	HH-P36	34-E-01	
L34121	3/4	(2)#12, (1)#12-G	HH-P36	SEC CLARIFIER #3 LTG; CKT 1	34-E-02	TO LP-D3B VIA L34120
L34122	3/4	(2)#12, (1)#12-G	HH-P36	SEC CLAR #3 RECPT; CKT 7	34-E-02	TO LP-D3B VIA L34120
P34001	4	(3)#500KCMIL, (1)#3-G	SWGR DA	MCC D3A	34-E-01	
P34051	4	(3)#500KCMIL, (1)#3-G	SWGR DB	MCC D3B	34-E-01	
P34060	1	(3)#10, (1)#10-G	MCC D3B	34-ME-01-A	34-E-01	MCC A/C UNIT
P34101	2	(3)#10, (24)#14-C, (1)#10-G	MCC D3A	34-ME-01-ML	34-E-01	
PX34001	4	PULL ROPE	SWGR DA	MCC D3A	34-E-01	
PX34051	4	PULL ROPE	SWGR DB	MCC D3B	34-E-01	
PX34101	4	PULL ROPE	HH-P101	HH-P107	E-05	
PX34102	4	PULL ROPE	HH-P101	HH-P107	E-05	
PX34201	2	PULL ROPE	MCC D3	HH-P36	34-E-01	
SX34101	2	PULL ROPE	HH-S101	HH-S107	E-05	
SX34102	2	PULL ROPE	HH-S101	HH-S107	E-05	
SX34201	2	PULL ROPE	34-CP-01	HH-S36	34-E-01	
P35101	2	PULL ROPE	MCC D3B	HH-P36	34-E-01	FUTURE SEC CLARIFIER 4
C36101	1	(8)#14-C	34-CP-01	36-LSLL/L/H/HH-H11	36-E-01	
C36103	1	(8)#14-C	34-CP-01	36-LSLL/L/H/HH-H6	36-E-01	
L36101	3/4	(2)#12, (1)#12-G	LP-D3A	36-F-02-FA	36-E-01	
L36102	3/4	(2)#12, (1)#12-G	LP-D3B	36-F-03-FA	36-E-01	
L36110	1 1/2	(10)#12, (5)#12-G	LP-D3A	HH-P36	34-E-01	
L36111	3/4	(2)#12, (1)#12-G	HH-P36	RAS PS BOTTOM LTG; CKT 3	36-E-02	TO LP-D3A VIA L36110
L36112	3/4	(2)#12, (1)#12-G	HH-P36	RAS PS BTM EMRG LTG; CKT 4	36-E-02	TO LP-D3A VIA L36110

Conduit Tag	Size [in.]	Fill	From	To	Dwg Ref.	Comments
L36113	3/4	(2)#12, (1)#12-G	HH-P36	RAS PS BTM RECPT; CKT 9	36-E-02	TO LP-D3A VIA L36110
L36114	3/4	(2)#12, (1)#12-G	HH-P36	RAS PS TOP LTG; CKT 6	36-E-03	TO LP-D3A VIA L36110
L36115	3/4	(2)#12, (1)#12-G	HH-P36	RAS PS TOP RECPT; CKT 8	36-E-03	TO LP-D3A VIA L36110
L36120	1 1/2	(10)#12, (5)#12-G	LP-D3B	HH-P36	34-E-01	
L36121	3/4	(2)#12, (1)#12-G	HH-P36	RAS PS BTM LTG; CKT3	36-E-02	TO LP-D3B VIA L36120
L36122	3/4	(2)#12, (1)#12-G	HH-P36	RAS PS TOP EXTR LTG;CKT 4	36-E-03	TO LP-D3B VIA L36120
L36123	3/4	(2)#12, (1)#12-G	HH-P36	RAS PS BTM RECPT; CKT 9	36-E-02	TO LP-D3B VIA L36120
L36124	3/4	(2)#12, (1)#12-G	HH-P36	RAS PS TOP LTG; CKT 6	36-E-03	TO LP-D3B VIA L36120
L36125	3/4	(2)#12, (1)#12-G	HH-P36	RAS PS TOP RECPT; CKT 8	36-E-03	TO LP-D3B VIA L36120
L36157	3/4	(2)#12, (1)#12-G	LP-D3B	36-FE/FIT-H4	36-E-01	
P36101	1 1/2	(3)#10, (16)#14-C, (1)#10-G	MCC D3A	36-P-01-PD	36-E-01	
P36102	2	PULL ROPE	MCC D3A	FUTURE 36-P-01-RAS	36-E-01	
P36103	2	(3)#6, (16)#14-C, (4)#12-C, (1)#10-G	MCC D3A	36-P-03-RAS	36-E-01	
P36104	1 1/2	(3)#12, (14)#14-C, (2)#12-C, (1)#12-G	MCC D3A	36-B-01-FA	36-E-01	
P36105	2	(3)#12, (18)#14-C, (4)#12-C, (1)#12-G	MCC D3A	36-P-01-S	36-E-01	
P36151	1	(3)#12, (4)#14-C, (1)#12-G	MCC D3B	36-F-01-FA	36-E-01	
P36152	1 1/2	(3)#10, (16)#14-C, (1)#10-G	MCC D3B	36-P-02-PD	36-E-01	
P36153	2	(3)#6, (16)#14-C, (4)#12-C, (1)#10-G	MCC D3B	36-P-02-RAS	36-E-01	
P36154	2	(3)#12, (18)#14-C, (4)#12-C, (1)#12-G	MCC D3B	36-P-02-S	36-E-01	
PX36201	2	PULL ROPE	MCC D3	HH-P36	34-E-01	
PX36202	2	PULL ROPE	MCC D3	HH-P36	34-E-01	
PX36203	2	PULL ROPE	MCC D3	HH-P36	34-E-01	
S36100	1 1/2	(2)TSP-C, (2)TST-C	MCC D3A	HH-S36	34-E-01	
S36102	1 1/4	PULL ROPE	MCC D3A	FUTURE 36-P-01-RAS	36-E-01	
S36103	1 1/4	(1)TSP-C, (1)TST-C	HH-S36	36-P-03-RAS	36-E-01	TO MCC D3A VIA S36100
S36105	1 1/4	(1)TSP-C, (1)TST-C	HH-S36	36-P-01-S	36-E-01	TO MCC D3A VIA S36100
S36150	2	(3)TSP-C, (2)TST-C	MCC D3B	HH-S36	34-E-01	
S36153	1 1/4	(1)TSP-C, (1)TST-C	HH-S36	36-P-02-RAS	36-E-01	TO MCC D3B VIA S36150
S36154	1 1/4	(1)TSP-C, (1)TST-C	HH-S36	36-P-02-S	36-E-01	TO MCC D3B VIA S36150
S36157	3/4	(1)TSP-C	HH-S36	36-FE/FIT-H4	36-E-01	TO 34-CP-01 VIA S36150
SX36201	2	PULL ROPE	34-CP-01	HH-S36	34-E-01	
L40110	3/4	(2)#12, (1)#12-G	(E) PANEL E	62-AE/AIT-K410	40-E-01	
N40101	3/4	(1)Cat6-C	(E) SWGR C	(E) 43-CP-01	40-E-01	

Conduit Tag	Size [in.]	Fill	From	To	Dwg Ref.	Comments
S40110	3/4	(1)TSP-C	(E) 43-CP-01	62-AE/AIT-K410	40-E-01	
L50001	3/4	(2)#12, (1)#12-G	(E) PNL F	50-AE/AIT-J12-1 AND CONTROLLER RECEPTACLE	50-E-01	
S50001	3/4	(1)TSP-C	(E) 50-CP-01	50-AE/AIT-J12-1	50-E-01	
C51101	1 1/4	(12)#14-C	51-ASD-01-AA	16-CP-02	16-E-01	
C51102	1 1/4	(12)#14-C	51-ASD-02-AA	16-CP-02	16-E-01	
C51110A	2	(18)#14-C, (6)#14-S	51-CP-01	JUNCTION BOX	51-E-01	WAS STORAGE AIR MOVs
C51110B	2 1/2	(46)#14-C, (10)#14-S	51-CP-01	JUNCTION BOX	51-E-01	WAS STORAGE SLUDGE AND DRAIN MOVs
C51110C	2 1/2	(36)#14-C, (8)#14-S	51-CP-01	JUNCTION BOX	51-E-01	WAS STORAGE SLUDGE MOVs
C51110D	2	(30)#14-C, (6)#14-S	51-CP-01	JUNCTION BOX	51-E-01	WAS STORAGE TANK 1 DECANT MOVs
C51110E	2	(30)#14-C, (6)#14-S	51-CP-01	JUNCTION BOX	51-E-01	WAS STORAGE TANK 2 DECANT MOVs
C51110F	2	(30)#14-C, (6)#14-S	51-CP-01	JUNCTION BOX	51-E-01	WAS STORAGE TANK 3 DECANT MOVs
C51111	1 1/4	(10)#14-C, (2)#14-S	JUNCTION BOX	51-V-01-WAS	51-E-01	FROM 51-CP-01 VIA C51110B
C51112	1 1/4	(10)#14-C, (2)#14-S	JUNCTION BOX	51-V-04-WAS	51-E-01	FROM 51-CP-01 VIA C51110C
C51113	1 1/4	(10)#14-C, (2)#14-S	JUNCTION BOX	51-V-01-DEC	51-E-01	FROM 51-CP-01 VIA C51110D
C51114	1 1/4	(10)#14-C, (2)#14-S	JUNCTION BOX	51-V-02-DEC	51-E-01	FROM 51-CP-01 VIA C51110D
C51115	1 1/4	(10)#14-C, (2)#14-S	JUNCTION BOX	51-V-03-DEC	51-E-01	FROM 51-CP-01 VIA C51110D
C51116	1	(6)#14-C, (2)#14-S	JUNCTION BOX	51-V-01-AA	51-E-01	FROM 51-CP-01 VIA C51110A
C51121	1 1/4	(10)#14-C, (2)#14-S	JUNCTION BOX	51-V-02-WAS	51-E-01	FROM 51-CP-01 VIA C51110B
C51122	1 1/4	(10)#14-C, (2)#14-S	JUNCTION BOX	51-V-05-WAS	51-E-01	FROM 51-CP-01 VIA C51110C
C51123	1 1/4	(10)#14-C, (2)#14-S	JUNCTION BOX	51-V-04-DEC	51-E-01	FROM 51-CP-01 VIA C51110E
C51124	1 1/4	(10)#14-C, (2)#14-S	JUNCTION BOX	51-V-05-DEC	51-E-01	FROM 51-CP-01 VIA C51110E
C51125	1 1/4	(10)#14-C, (2)#14-S	JUNCTION BOX	51-V-06-DEC	51-E-01	FROM 51-CP-01 VIA C51110E
C51126	1	(6)#14-C, (2)#14-S	JUNCTION BOX	51-V-02-AA	51-E-01	FROM 51-CP-01 VIA C51110A
C51131	1 1/4	(10)#14-C, (2)#14-S	JUNCTION BOX	51-V-03-WAS	51-E-01	FROM 51-CP-01 VIA C51110B
C51132	1 1/4	(10)#14-C, (2)#14-S	JUNCTION BOX	51-V-06-WAS	51-E-01	FROM 51-CP-01 VIA C51110C
C51133	1 1/4	(10)#14-C, (2)#14-S	JUNCTION BOX	51-V-07-DEC	51-E-01	FROM 51-CP-01 VIA C51110F
C51134	1 1/4	(10)#14-C, (2)#14-S	JUNCTION BOX	51-V-08-DEC	51-E-01	FROM 51-CP-01 VIA C51110F
C51135	1 1/4	(10)#14-C, (2)#14-S	JUNCTION BOX	51-V-09-DEC	51-E-01	FROM 51-CP-01 VIA C51110F
C51136	1	(6)#14-C, (2)#14-S	JUNCTION BOX	51-V-03-AA	51-E-01	FROM 51-CP-01 VIA C51110A
C51138	1 1/4	(10)#14-C, (2)#14-S	JUNCTION BOX	51-V-01-D	51-E-01	FROM 51-CP-01 VIA C51110B
C51141	1	(6)#14-C, (2)#14-S	JUNCTION BOX	51-V-08-WAS	51-E-01	FROM 51-CP-01 VIA C51110B
C51142	1	(6)#14-C, (2)#14-S	JUNCTION BOX	51-V-10-WAS	51-E-01	FROM 51-CP-01 VIA C51110C
EL51000A	1 1/4	(6)#12, (3)#12-G	LP-B5U	JUNCTION BOX	51-E-01	WAS STORAGE EAST INSTRUMENTS
EL51000B	1 1/2	(12)#12, (6)#12-G	LP-B5U	JUNCTION BOX	51-E-01	WAS STORAGE WEST INSTRUMENTS

Conduit Tag	Size [in.]	Fill	From	To	Dwg Ref.	Comments
EL51001	3/4	(2)#12, (1)#12-G	JUNCTION BOX	51-FE/FIT-N1	51-E-01	FROM LP-B5U VIA EL51000B
EL51002	3/4	(2)#12, (1)#12-G	JUNCTION BOX	51-FE/FIT-N7	51-E-01	FROM LP-B5U VIA EL51000A
EL51003	3/4	(2)#12, (1)#12-G	JUNCTION BOX	51-FE/FIT-N8	51-E-01	FROM LP-B5U VIA EL51000A
EL51004	3/4	(2)#12, (1)#12-G	JUNCTION BOX	51-FE/FIT-N9	51-E-01	FROM LP-B5U VIA EL51000A
EL51005	3/4	(2)#12, (1)#12-G	JUNCTION BOX	51-AE/AIT-N1	51-E-01	FROM LP-B5U VIA EL51000B
EL51006	3/4	(2)#12, (1)#12-G	JUNCTION BOX	51-AE/AIT-N28	51-E-01	FROM LP-B5U VIA EL51000B
EL51007	3/4	(2)#12, (1)#12-G	JUNCTION BOX	51-LE/LIT-N25	51-E-01	FROM LP-B5U VIA EL51000B
EL51008	3/4	(2)#12, (1)#12-G	JUNCTION BOX	51-LE/LIT-N26	51-E-01	FROM LP-B5U VIA EL51000B
EL51009	3/4	(2)#12, (1)#12-G	JUNCTION BOX	51-LE/LIT-N27	51-E-01	FROM LP-B5U VIA EL51000B
EL51100	2 1/2	(4)#1, (1)#6-G	UPS-D2U	LP-B5U	51-E-01	
EL51200	3/4	(2)#12, (1)#12-G	LP-B5U	51-CP-01	51-E-01	
FO51001	1	(1) 12 FO CABLE	27-CP-01	51-CP-01	51-E-01	
L51200	3/4	(2)#12, (1)#12-G	LP-B5A	51-CP-01	51-E-01	
N51101	3/4	(1)Cat6-C	51-ASD-01-AA	16-CP-02	16-E-01	
N51102	3/4	(1)Cat6-C	51-ASD-02-AA	16-CP-02	16-E-01	
P51100A	3	(6)#10, (2)#12-G	DPB2	(E) HANDHOLE P4	E-04	WAS STORAGE TANKS 1 AND 2 VALVES. REUSE EXISTING CONDUIT
P51100B	3	(6)#10, (2)#12-G	DPB2	(E) HANDHOLE P4	E-04	WAS STORAGE TANKS 3 AND INFLUENT VALVES. REUSE EXISTING CONDUIT
P51101	1 1/2	(3)#2, (1)#8-G	DPB2	51-ASD-01-AA	16-E-01	
P51101A	3	(3)#2/0, (16)#14-C, (2)#12-C, (1)#6-G	51-ASD-01-AA	51-B-01-AA	51-E-01	
P51102	1 1/2	(3)#2, (1)#8-G	DPB2	51-ASD-02-AA	16-E-01	
P51102A	3	(3)#2/0, (16)#14-C, (2)#12-C, (1)#6-G	51-ASD-02-AA	51-B-02-AA	51-E-01	
P51110	1	(3)#10, (1)#12-G	(E) HANDHOLE P4	JUNCTION BOX	51-E-01	FROM DPB2 VIA P51100A
P51111	1	(3)#10, (1)#12-G	JUNCTION BOX	51-V-01-WAS	51-E-01	FROM DPB2 VIA P51110, P51100A
P51112	1	(3)#10, (1)#12-G	JUNCTION BOX	51-V-04-WAS	51-E-01	FROM DPB2 VIA P51110, P51100A
P51113	1	(3)#10, (1)#12-G	JUNCTION BOX	51-V-01-DEC	51-E-01	FROM DPB2 VIA P51110, P51100A
P51114	1	(3)#10, (1)#12-G	JUNCTION BOX	51-V-02-DEC	51-E-01	FROM DPB2 VIA P51110, P51100A
P51115	1	(3)#10, (1)#12-G	JUNCTION BOX	51-V-03-DEC	51-E-01	FROM DPB2 VIA P51110, P51100A
P51116	1	(3)#10, (1)#12-G	JUNCTION BOX	51-V-01-AA	51-E-01	FROM DPB2 VIA P51110, P51100A

Conduit Tag	Size [in.]	Fill	From	To	Dwg Ref.	Comments
P51120	1	(3)#10, (1)#12-G	(E) HANDHOLE P4	JUNCTION BOX	51-E-01	FROM DPB2 VIA P51100A
P51121	1	(3)#10, (1)#12-G	JUNCTION BOX	51-V-02-WAS	51-E-01	FROM DPB2 VIA P51120, P51100A
P51122	1	(3)#10, (1)#12-G	JUNCTION BOX	51-V-05-WAS	51-E-01	FROM DPB2 VIA P51120, P51100A
P51123	1	(3)#10, (1)#12-G	JUNCTION BOX	51-V-04-DEC	51-E-01	FROM DPB2 VIA P51120, P51100A
P51124	1	(3)#10, (1)#12-G	JUNCTION BOX	51-V-05-DEC	51-E-01	FROM DPB2 VIA P51120, P51100A
P51125	1	(3)#10, (1)#12-G	JUNCTION BOX	51-V-06-DEC	51-E-01	FROM DPB2 VIA P51120, P51100A
P51126	1	(3)#10, (1)#12-G	JUNCTION BOX	51-V-02-AA	51-E-01	FROM DPB2 VIA P51120, P51100A
P51130	1	(3)#10, (1)#12-G	(E) HANDHOLE P4	JUNCTION BOX	51-E-01	FROM DPB2 VIA P51100B
P51131	1	(3)#10, (1)#12-G	JUNCTION BOX	51-V-03-WAS	51-E-01	FROM DPB2 VIA P51130, P51100B
P51132	1	(3)#10, (1)#12-G	JUNCTION BOX	51-V-06-WAS	51-E-01	FROM DPB2 VIA P51130, P51100B
P51133	1	(3)#10, (1)#12-G	JUNCTION BOX	51-V-07-DEC	51-E-01	FROM DPB2 VIA P51130, P51100B
P51134	1	(3)#10, (1)#12-G	JUNCTION BOX	51-V-08-DEC	51-E-01	FROM DPB2 VIA P51130, P51100B
P51135	1	(3)#10, (1)#12-G	JUNCTION BOX	51-V-09-DEC	51-E-01	FROM DPB2 VIA P51130, P51100B
P51136	1	(3)#10, (1)#12-G	JUNCTION BOX	51-V-03-AA	51-E-01	FROM DPB2 VIA P51130, P51100B
P51138	1	(3)#10, (1)#12-G	JUNCTION BOX	51-V-01-D	51-E-01	FROM DPB2 VIA P51130, P51100B
P51140	1	(3)#10, (1)#12-G	(E) HANDHOLE P4	JUNCTION BOX	51-E-01	FROM DPB2 VIA P51100B
P51141	1	(3)#10, (1)#12-G	JUNCTION BOX	51-V-08-WAS	51-E-01	FROM DPB2 VIA P51140, P51100B
P51142	1	(3)#10, (1)#12-G	JUNCTION BOX	51-V-10-WAS	51-E-01	FROM DPB2 VIA P51140, P51100B
P51150	1 1/4	(3)#6, (1)#10-G	MCC-B1	LP-B5A	51-E-01	
P51155	1 1/4	(3)#6, (1)#10-G	DPB2	LP-B5B	51-E-01	
PX51101	4	PULL ROPE	HH-P103	HH-P104	E-04	
PX51102	4	PULL ROPE	HH-P103	HH-P104	E-04	
S51000A	1 1/4	(3)TSP-C	51-CP-01	JUNCTION BOX	51-E-01	WAS STORAGE EAST INSTRUMENTS
S51000B	2	(6)TSP-C	51-CP-01	JUNCTION BOX	51-E-01	WAS STORAGE WEST INSTRUMENTS
S51001	3/4	(1)TSP-C	JUNCTION BOX	51-FE/FIT-N1	51-E-01	FROM 51-CP-01 VIA S51000B
S51002	3/4	(1)TSP-C	JUNCTION BOX	51-FE/FIT-N7	51-E-01	FROM 51-CP-01 VIA S51000A
S51003	3/4	(1)TSP-C	JUNCTION BOX	51-FE/FIT-N8	51-E-01	FROM 51-CP-01 VIA S51000A

Conduit Tag	Size [in.]	Fill	From	To	Dwg Ref.	Comments
S51004	3/4	(1)TSP-C	JUNCTION BOX	51-FE/FIT-N9	51-E-01	FROM 51-CP-01 VIA S51000A
S51005	3/4	(1)TSP-C	JUNCTION BOX	51-AE/AIT-N1	51-E-01	FROM 51-CP-01 VIA S51000B
S51006	3/4	(1)TSP-C	JUNCTION BOX	51-AE/AIT-N28	51-E-01	FROM 51-CP-01 VIA S51000B
S51007	3/4	(1)TSP-C	JUNCTION BOX	51-LE/LIT-N25	51-E-01	FROM 51-CP-01 VIA S51000B
S51008	3/4	(1)TSP-C	JUNCTION BOX	51-LE/LIT-N26	51-E-01	FROM 51-CP-01 VIA S51000B
S51009	3/4	(1)TSP-C	JUNCTION BOX	51-LE/LIT-N27	51-E-01	FROM 51-CP-01 VIA S51000B
S51101	1 1/4	(2)TSP-C	51-ASD-01-AA	16-CP-02	16-E-01	
S51101A	1 1/4	(1)TSP-C, (1)TST-C	51-ASD-01-AA	51-CS-05	51-E-01	
S51102	1 1/4	(2)TSP-C	51-ASD-02-AA	16-CP-02	16-E-01	
S51102A	1 1/4	(1)TSP-C, (1)TST-C	51-ASD-02-AA	51-CS-06	51-E-01	
S51110	2	(6)TSP-C	51-CP-01	JUNCTION BOX	51-E-01	WAS STORAGE EAST MOVs
S51116	1 1/4	(2)TSP-C	JUNCTION BOX	51-V-01-AA	51-E-01	FROM 51-CP-01 VIA S51110
S51126	1 1/4	(2)TSP-C	JUNCTION BOX	51-V-02-AA	51-E-01	FROM 51-CP-01 VIA S51110
S51136	1 1/4	(2)TSP-C	JUNCTION BOX	51-V-03-AA	51-E-01	FROM 51-CP-01 VIA S51110
S51140	1 1/2	(4)TSP-C	51-CP-01	JUNCTION BOX	51-E-01	WAS STORAGE WEST MOVs
S51141	1 1/4	(2)TSP-C	JUNCTION BOX	51-V-08-WAS	51-E-01	FROM 51-CP-01 VIA S51140
S51142	1 1/4	(2)TSP-C	JUNCTION BOX	51-V-10-WAS	51-E-01	FROM 51-CP-01 VIA S51140
SX51101	2	PULL ROPE	HH-S103	HH-S104	E-04	
SX51102	2	PULL ROPE	HH-S103	HH-S104	E-04	
C52001	3/4	(2)#14-C	52-F-16-A	THERMOSTAT	52-E-01	PROVIDE ADDITIONAL WIRES AS REQUIRED. NOTE 1
C52011	1	(10)#12-C	52-SV-01-CA, 52-SV-02-CA, 52-SV-03-CA, 52-SV-04-CA, 52-SV-05-CA	52-MCP-01	52-E-01	NOTE 1
C52012	1	(10)#14-C, (4)#12-C	52-LSL/LSH/LSHH-O10, 52-SV-01-DWS, 52-SV-02-DWS, 52-ZS-O20-1, 52-ZS-O20-2	52-MCP-01	52-E-01	NOTE 1
C52012A	3/4	(4)#14-C	CONDUIT C52012/JBOX	52-ZS-O20-1, 52-ZS-O20-2	52-E-01	NOTE 1
C52013	1	(8)#14-C	52-PSH-O15, 52-PSH-O16, 52-ZSH-O19-1, 52-ZSH-O19-2	52-MCP-01	52-E-01	NOTE 1
C52020	3/4	(2)#12-C	52-SV-20-CA	52-MCP-01	52-E-01	NOTE 1
C52030	1 1/4	(2)#12-C, (8)#14-C	JUNCTION BOX	52-MCP-01	52-E-01	FROM 52-FSL-O82, 52-PSL-O82, 52-LSH-O82, 52-PSL-073, 52-SV-30-CA. NOTE 1
C52044	1 1/4	(6)#12-C, (12)#14-C	52-LCP-01	AREA 52 LOADOUT GATES	52-E-01	NOTE 1
C52044A	1	(2)#12-C, (4)#14-C	CONDUIT C52044/JBOX	52-G-01-DRS	52-E-01	FROM 52-LCP-01 VIA C52044. NOTE 1
C52044B	1	(2)#12-C, (4)#14-C	CONDUIT C52044/JBOX	52-G-02-DRS	52-E-01	FROM 52-LCP-01 VIA C52044. NOTE 1
C52044C	1	(2)#12-C, (4)#14-C	CONDUIT C52044/JBOX	52-G-03-DRS	52-E-01	FROM 52-LCP-01 VIA C52044. NOTE 1

Conduit Tag	Size [in.]	Fill	From	To	Dwg Ref.	Comments
C52045	2	SEE COMMENT	52-LCP-01	LOCAL PENDANT CONTROLLER	52-E-01	FINAL CONDUIT FILL AS SPECIFIED BY DRYER SYSTEM SUPPLIER. NOTE 1
C52046	1 1/2	(6)#12-C, (12)#14-C	52-LCP-01	AREA 52 DUST VALVES	52-E-01	NOTE 1
C52046A	1	(2)#12-C, (4)#14-C	CONDUIT C52046/JBOX	52-V-01-DC	52-E-01	FROM 52-LCP-01 VIA C52046. NOTE 1
C52046B	1	(2)#12-C, (4)#14-C	CONDUIT C52046/JBOX	52-V-02-DC	52-E-01	FROM 52-LCP-01 VIA C52046. NOTE 1
C52046C	1	(2)#12-C, (4)#14-C	CONDUIT C52046/JBOX	52-V-03-DC	52-E-01	FROM 52-LCP-01 VIA C52046. NOTE 1
C52051	3/4	(2)#14-C	52-FSL-O51	52-MCP-01	52-E-01	NOTE 1
C52055	3/4	(2)#14-C	52-LSH-O55	52-MCP-01	52-E-01	NOTE 1
C52060	1	(6)#12-C	52-LCP-02	52-SV-10-CA, 52-SV-11-CA, 52-SV-12-CA	52-E-01	NOTE 1
C52063	1	(6)#14-C	52-LCP-02	52-LSH-O63, 52-LSL-O63, 52-PSL-O63	52-E-01	NOTE 1
C52065	1	(6)#14-C	52-LCP-02	52-HS-O65, 52-LSL-O65, 52-TSH-O65	52-E-01	NOTE 1
C52073	3/4	(2)#14-C	52-PSL-O73	JUNCTION BOX	52-E-01	TO 52-MCP-01 VIA C52030. NOTE 1
C52075	2	SEE COMMENT	52-MCP-01	52-LCP-04	52-E-01	NOTE 1
C52079	3/4	(2)#12-C	52-PSL-O79	52-MCP-01	52-E-01	NOTE 1
C52080	3/4	(2)#12-C	52-SV-30-CA	JUNCTION BOX	52-E-01	TO 52-MCP-01 VIA C52030. NOTE 1
C52082A	3/4	(2)#14-C	52-FSL-O82	JUNCTION BOX	52-E-01	TO 52-MCP-01 VIA C52030. NOTE 1
C52082B	3/4	(2)#14-C	52-PSL-O82	JUNCTION BOX	52-E-01	TO 52-MCP-01 VIA C52030. NOTE 1
C52082C	3/4	(2)#14-C	52-LSH-O82	JUNCTION BOX	52-E-01	TO 52-MCP-01 VIA C52030. NOTE 1
C52103	2	SEE COMMENT	52-MCP-01	52-LCP-03	52-E-01	FINAL CONDUIT FILL AS SPECIFIED BY DRYER SYSTEM SUPPLIER. NOTE 1
C52110	2	SEE COMMENT	52-MCP-01	52-ASD-11-DRS	52-E-01	FINAL CONDUIT FILL AS SPECIFIED BY DRYER SYSTEM SUPPLIER. NOTE 1
C52120A	2	SEE COMMENT	52-MCP-01	52-LCP-01	52-E-01	FINAL CONDUIT FILL AS SPECIFIED BY DRYER SYSTEM SUPPLIER. NOTE 1
C52120B	2	SEE COMMENT	52-MCP-01	52-LCP-01	52-E-01	FINAL CONDUIT FILL AS SPECIFIED BY DRYER SYSTEM SUPPLIER. NOTE 1
C52140A	2	SEE COMMENT	52-MCP-01	52-LCP-02	52-E-01	FINAL CONDUIT FILL AS SPECIFIED BY DRYER SYSTEM SUPPLIER. NOTE 1

Conduit Tag	Size [in.]	Fill	From	To	Dwg Ref.	Comments
C52140B	2	SEE COMMENT	52-MCP-01	52-LCP-02	52-E-01	FINAL CONDUIT FILL AS SPECIFIED BY DRYER SYSTEM SUPPLIER. NOTE 1
C52171	3/4	(8)#14	52-LCP-11	52-CP-01	52-E-01	NOTE 1
C52172	1 1/4	(32)#14-C	JBOX	52-CP-01	52-E-01	NOTE 1
C52172A	3/4	(8)#14	52-LCP-12	CONDUIT C52172/JBOX	52-E-01	NOTE 1
C52172B	3/4	(2)#14	52-LCP-12	THERMOSTAT	52-E-01	NOTE 1
C52173	3/4	(8)#14	52-LCP-13	CONDUIT C52172/JBOX	52-E-01	NOTE 1
C52173A	3/4	(2)#14	52-LCP-13	THERMOSTAT	52-E-01	NOTE 1
C52174	3/4	(8)#14	52-LCP-14	CONDUIT C52172/JBOX	52-E-01	NOTE 1
C52174A	3/4	(2)#14	52-LCP-14	THERMOSTAT	52-E-01	NOTE 1
C52175	3/4	(8)#14	52-LCP-15	CONDUIT C52172/JBOX	52-E-01	NOTE 1
C52175A	3/4	(2)#14	52-LCP-15	THERMOSTAT	52-E-01	NOTE 1
C52201A	2	SEE COMMENT	MCC-D1	52-MCP-01	52-E-03	FINAL CONDUIT FILL AS SPECIFIED BY DRYER SYSTEM SUPPLIER. NOTE 1
C52201B	2	SEE COMMENT	MCC-D1	52-MCP-01	52-E-03	FINAL CONDUIT FILL AS SPECIFIED BY DRYER SYSTEM SUPPLIER. NOTE 1
CX52010	1	PULL ROPE	PB-C52000	MCC D1	52-E-01	NOTE 1
CX52011	1	PULL ROPE	PB-C52000	MCC D1	52-E-01	NOTE 1
CX52012	2	PULL ROPE	PB-C52000	52-MCP-01	52-E-01	NOTE 1
CX52013	2	PULL ROPE	PB-C52000	52-MCP-01	52-E-01	NOTE 1
CX52014	2	PULL ROPE	PB-C52000	52-CP-01	52-E-01	NOTE 1
CX52015	2	PULL ROPE	PB-C52000	52-CP-01	52-E-01	NOTE 1
EL52002	3/4	(2)#12, (1)#12-G	LP-D1U	DPD1	52-E-01	NOTE 1
EL52009	1	(4)#12, (2)#12-G	52-MCP-01	52-LE/LIT-O10-1, 52-LE/LIT-O10-2	52-E-01	NOTE 1
EL52010	3/4	(2)#12, (1)#12-G	LP-D1U	MCC D1 NETWORK SWITCH	52-E-03	NOTE 1
EL52034	3/4	(2)#12, (1)#12-G	52-MCP-01	52-FE/FIT-O34	52-E-01	NOTE 1
EL52069	3/4	(2)#12, (1)#12-G	52-LCP-02	52-FE/FIT-O69	52-E-01	NOTE 1
EL52077	3/4	(2)#12, (1)#12-G	52-MCP-01	52-WIT-O77	52-E-01	NOTE 1
EL52078	3/4	(2)#12, (1)#12-G	52-MCP-01	52-FE/FIT-O78	52-E-01	NOTE 1
EL52120	3/4	(2)#10, (1)#10-G	LP-D1U	52-LCP-01	52-E-03	NOTE 1
EL52140	3/4	(2)#10, (1)#10-G	LP-D1U	52-LCP-02	52-E-03	NOTE 1
EL52200	3/4	(2)#12, (1)#12-G	LP-D1U	52-CP-01	52-E-03	NOTE 1
EL52201	3/4	(2)#12, (1)#12-G	LP-D1U	52-MCP-01	52-E-03	NOTE 1
FA52001	2	12#16, 2#16 SP	BIOSOLIDS/DRYER BLDG	(E) FACP - OPERATIONS BLDG	52-E-01	FROM FA53001. FINAL CONDUIT FILL AS SPECIFIED BY FIRE ALARM SYSTEM SUPPLIER. NOTE 1

Conduit Tag	Size [in.]	Fill	From	To	Dwg Ref.	Comments
L52001A	3/4	(3)#12, (1)#12-G	LP-D1A	52-F-16-A	52-E-01	PROVIDE ADDITIONAL WIRES AS REQUIRED. NOTE 1
L52001B	3/4	(3)#12, (1)#12-G	52-F-16-A	52-F-17-A	52-E-01	PROVIDE ADDITIONAL WIRES AS REQUIRED. NOTE 1
L52050	3	(3)#3/0, (1)#3/0-N, (1)#6-G	XFMR-D1A	LP-D1A	52-E-01	NOTE 1
L52051	3/4	(2)#10, (1)#10-G	LP-D1B	HOIST	52-E-03	NOTE 1
L52055	1 1/2	(3)#2, (1)#8-G	LP-D1A	UPS-D1U	52-E-03	NOTE 1
L52101	3/4	(2)#12, (1)#12-G	LP-D1A	PARKING LOT LTG; CKT 20	E-03	NOTE 1
L52150	2 1/2	(3)#1, (1)#1-N, (1)#6-G	XFMR-D1B	LP-D1B	52-E-01	NOTE 1
L52200	1	(2)#8, (1)#8-G	LP-D1A	52-CP-01	52-E-03	NOTE 1
L52201	1	(2)#8, (1)#8-G	LP-D1B	52-MCP-01	52-E-03	NOTE 1
L52202	3/4	(2)#12, (1)#12-G	LP-D1B	52-LCP-04	52-E-03	NOTE 1
N52001	1	(1)Cat6-C	52-MCP-01	52-CP-01	52-E-01	NOTE 1
N52101	1	(1)Cat6-C	DPD1	52-CP-01	52-E-03	NOTE 1
N52102	1	(1)Cat6-C	MCC D1	52-MCP-01	52-E-03	NOTE 1
N52120	2	SEE COMMENT	52-MCP-01	52-LCP-01	52-E-01	FINAL CONDUIT FILL AS SPECIFIED BY DRYER SYSTEM SUPPLIER. NOTE 1
N52140	2	SEE COMMENT	52-MCP-01	52-LCP-02	52-E-01	FINAL CONDUIT FILL AS SPECIFIED BY DRYER SYSTEM SUPPLIER. NOTE 1
N52201	2	SEE COMMENT	MCC-D1	52-MCP-01	52-E-03	FINAL CONDUIT FILL AS SPECIFIED BY DRYER SYSTEM SUPPLIER. NOTE 1
P52001A	4	(3)#500KCMIL, (1)#2/0-G	SWGR DA	DPD1	52-E-01	NOTE 1
P52001B	4	(3)#500KCMIL, (1)#2/0-G	SWGR DA	DPD1	52-E-01	NOTE 1
P52001C	4	(3)#500KCMIL, (1)#2/0-G	SWGR DA	DPD1	52-E-01	NOTE 1
P52010A	4	(3)#300KCMIL, (1)#1/0-G	DPD1	MCC D1	52-E-01	NOTE 1
P52010B	4	(3)#300KCMIL, (1)#1/0-G	DPD1	MCC D1	52-E-01	NOTE 1
P52010C	4	(3)#300KCMIL, (1)#1/0-G	DPD1	MCC D1	52-E-01	NOTE 1
P52050	1 1/4	(3)#4, (1)#8-G	DPD1	XFMR-D1A	52-E-01	NOTE 1
P52101	1	(3)#12, (4)#14-C, (1)#12-G	MCC D1	52-ME-11-DWS	52-E-03	NOTE 1
P52102	1	(3)#12, (4)#14-C, (1)#12-G	MCC D1	52-ME-12-DWS	52-E-03	NOTE 1
P52103A	1	(3)#8, (1)#8-G	52-LCP-03	52-COMP-01-CA	52-E-01	NOTE 1
P52103B	1	(3)#8, (1)#8-G	52-LCP-03	52-COMP-02-CA	52-E-01	NOTE 1
P52103	1 1/4	(3)#8, (1)#10-G	MCC D1	52-LCP-03	52-E-03	AIR COMPRESSORS LCP. NOTE 1
P52104	1 1/4	(3)#6, (4)#14-C, (1)#10-G	MCC D1	52-P-01-DWS	52-E-03	NOTE 1
P52105	1 1/4	(3)#6, (4)#14-C, (1)#10-G	MCC D1	52-P-02-DWS	52-E-03	NOTE 1
P52110A	2 1/2	(3)#4/0, (2)#14-C, (1)#4-G	52-ASD-11-DRS	52-ME-11-DRS	52-E-01	NOTE 1
P52110	2 1/2	(3)#4/0, (1)#4-G	MCC D1	52-ASD-11-DRS	52-E-03	NOTE 1

Conduit Tag	Size [in.]	Fill	From	To	Dwg Ref.	Comments
P52111	3/4	(3)#12, (1)#12-G	MCC D1	52-F-11-DRS	52-E-03	NOTE 1
P52112	1	(3)#12, (4)#14-C, (1)#12-G	MCC D1	52-G-11-DRS	52-E-03	NOTE 1
P52113	1 1/4	(3)#10, (6)#14-C, (1)#12-G	MCC D1	52-V-11-DRS	52-E-03	NOTE 1
P52114	1 1/4	(3)#10, (4)#14-C, (1)#12-G	MCC D1	52-ME-01-DRS	52-E-03	NOTE 1
P52115	1 1/4	(3)#10, (4)#14-C, (1)#12-G	MCC D1	52-ME-02-DRS	52-E-03	NOTE 1
P52116	1 1/4	(3)#10, (4)#14-C, (1)#12-G	MCC D1	52-ME-03-DRS	52-E-03	NOTE 1
P52117	1 1/4	(3)#10, (8)#14-C, (2)#12-C, (1)#12-G	MCC D1	52-ME-04-DRS	52-E-03	NOTE 1
P52118	1	(3)#12, (4)#14-C, (1)#12-G	MCC D1	52-ME-05-DRS	52-E-03	NOTE 1
P52119	1	(3)#12, (4)#14-C, (1)#12-G	52-LCP-01	52-ME-06-DRS	52-E-01	NOTE 1
P52120	1 1/4	(3)#6, (1)#10-G	MCC D1	52-LCP-01	52-E-03	LOADOUT CONVEYOR LCP. NOTE 1
P52121	1	(3)#12, (4)#14-C, (1)#12-G	52-LCP-01	52-ME-07-DRS	52-E-01	NOTE 1
P52122	1	(3)#12, (4)#14-C, (1)#12-G	52-LCP-01	52-ME-08-DRS	52-E-01	NOTE 1
P52123	1	(3)#12, (4)#14-C, (1)#12-G	52-LCP-01	52-ME-09-DRS	52-E-01	NOTE 1
P52130	1	(3)#12, (4)#14-C, (1)#12-G	MCC D1	52-ME-11-DRSR	52-E-03	NOTE 1
P52131	1	(3)#12, (4)#14-C, (1)#12-G	MCC D1	52-V-11-DRSR	52-E-03	NOTE 1
P52138	1	(3)#10, (1)#12-G	MCC D1	52-F-01-FA	52-E-03	NOTE 1
P52140	2 1/2	(3)#3/0, (1)#6-G	MCC D1	52-LCP-02	52-E-03	THERMAL FLUID SYSTEM LCP. NOTE 1
P52145	1 1/4	(3)#8, (1)#10-G	MCC D1	52-F-02-FA	52-E-03	NOTE 1
P52150	1 1/4	(3)#6, (1)#10-G	MCC D1	XFMR-D1B	52-E-03	NOTE 1
P52171	3/4	(3)#12, (1)#12-G	DPD1	52-F-11-A	52-E-01	VIA DISC SW. NOTE 1
P52172	3/4	(3)#12, (1)#12-G	DPD1	52-F-12-A	52-E-01	VIA DISC SW. NOTE 1
P52173	3/4	(3)#12, (1)#12-G	DPD1	52-F-13-A	52-E-01	VIA DISC SW. NOTE 1
P52174	3/4	(3)#12, (1)#12-G	DPD1	52-F-14-A	52-E-01	VIA DISC SW. NOTE 1
P52175	3/4	(3)#12, (1)#12-G	DPD1	52-F-15-A	52-E-01	VIA DISC SW. NOTE 1
P52176	1	(3)#10, (1)#10-G	DPD1	52-ME-01-A	52-E-01	VIA DISC SW. NOTE 1
P52181	3/4	(3)#12, (1)#12-G	DPD1	OVERHEAD COILING DOOR #1 (W)	52-E-01	VIA DISC SW. NOTE 1
P52182	3/4	(3)#12, (1)#12-G	DPD1	OVERHEAD COILING DOOR #2 (W)	52-E-01	VIA DISC SW. NOTE 1
P52183	3/4	(3)#12, (1)#12-G	DPD1	OVERHEAD COILING DOOR #3 (N)	52-E-01	VIA DISC SW. NOTE 1
P52241	1 1/2	(3)#1, (2)#12, (2)#14-C, (1)#6-G	52-LCP-02	52-P-01-TF	52-E-01	NOTE 1
P52242	1	(3)#10, (2)#12, (1)#10-G	52-LCP-02	52-F-01-TF	52-E-01	NOTE 1
PX52001	4	PULL ROPE	SWGR DA	DPD1	52-E-01	NOTE 1
PX52010	1	PULL ROPE	PB-C52000	DPD1	52-E-01	NOTE 1
PX52011	1	PULL ROPE	PB-C52000	DPD1	52-E-01	NOTE 1
PX52101	4	PULL ROPE	HH-P111	HH-P112	E-03	NOTE 1

Conduit Tag	Size [in.]	Fill	From	To	Dwg Ref.	Comments
PX52102	4	PULL ROPE	HH-P111	HH-P112	E-03	NOTE 1
S52009	1 1/4	(2)TSP-C	52-LE/LIT-O10-1, 52-LE/LIT-O10-2	52-MCP-01	52-E-01	NOTE 1
S52015	1 1/4	(2)TSP-C	52-PIT-O15, 52-PIT-O16	52-MCP-01	52-E-01	NOTE 1
S52020	2	(6)TSP-C	52-TE/TT-O20-1, 52-TE/TT-O20-2, 52-TE/TT-O20-3, 52-TE/TT-O20-4, 52-TE/TT-O26, 52-PIT-O20	52-MCP-01	52-E-01	NOTE 1
S52033	3/4	(1)TSP-C	52-TIT-O33	52-MCP-01	52-E-01	NOTE 1
S52034	3/4	(1)TSP-C	52-FE/FIT-O34	52-MCP-01	52-E-01	NOTE 1
S52055	1 1/4	(3)TSP-C	52-PDIT-O55, 52-TE/TIT-O51, 52-TIT-O56	52-MCP-01	52-E-01	NOTE 1
S52061	3/4	(1)TSP-C	52-LCP-02	52-TIT-O61	52-E-01	NOTE 1
S52069	3/4	(1)TSP-C	52-LCP-02	52-FE/FIT-O69	52-E-01	NOTE 1
S52075	2	SEE COMMENT	52-LCP-04	52-MCP-01	52-E-01	FINAL CONDUIT FILL AS SPECIFIED BY DRYER SYSTEM SUPPLIER. NOTE 1
S52077	3/4	(2)TSP-C	52-WIT-O77	52-MCP-01	52-E-01	NOTE 1
S52078	3/4	(1)TSP-C	52-FE/FIT-O78	52-MCP-01	52-E-01	NOTE 1
S52080	3/4	(1)TSP-C	52-PDIT-O80	52-MCP-01	52-E-01	NOTE 1
S52110	2	SEE COMMENT	52-ASD-11-DRS	52-MCP-01	52-E-01	FINAL CONDUIT FILL AS SPECIFIED BY DRYER SYSTEM SUPPLIER. NOTE 1
S52112	3/4	(1)TSP-C	MCC D1	52-ZT-O24	52-E-01	NOTE 1
S52120A	3	SEE COMMENT	52-MCP-01	52-LCP-01	52-E-01	FINAL CONDUIT FILL AS SPECIFIED BY DRYER SYSTEM SUPPLIER. NOTE 1
S52120B	3	SEE COMMENT	52-MCP-01	52-LCP-01	52-E-01	FINAL CONDUIT FILL AS SPECIFIED BY DRYER SYSTEM SUPPLIER; INCLUDING NETWORK WIRE. NOTE 1
S52140A	3	SEE COMMENT	52-MCP-01	52-LCP-02	52-E-01	FINAL CONDUIT FILL AS SPECIFIED BY DRYER SYSTEM SUPPLIER. NOTE 1
S52140B	3	SEE COMMENT	52-MCP-01	52-LCP-02	52-E-01	FINAL CONDUIT FILL AS SPECIFIED BY DRYER SYSTEM SUPPLIER. NOTE 1
SX52010	2	PULL ROPE	PB-S52000	MCC D1	52-E-01	NOTE 1
SX52011	2	PULL ROPE	PB-S52000	MCC D1	52-E-01	NOTE 1
SX52012	2	PULL ROPE	PB-S52000	52-MCP-01	52-E-01	NOTE 1
SX52013	2	PULL ROPE	PB-S52000	52-MCP-01	52-E-01	NOTE 1
SX52014	2	PULL ROPE	PB-S52000	52-CP-01	52-E-01	NOTE 1
SX52015	2	PULL ROPE	PB-S52000	52-CP-01	52-E-01	NOTE 1

Conduit Tag	Size [in.]	Fill	From	To	Dwg Ref.	Comments
SX52101	2	PULL ROPE	HH-S111	HH-S112	E-03	NOTE 1
SX52102	2	PULL ROPE	HH-S111	HH-S112	E-03	NOTE 1
FA53001	2	6#16, 2#16 SP	BIOSOLID STORAGE AREA	HH-S112	53-E-01	FINAL CONDUIT FILL AS SPECIFIED BY FIRE ALARM SYSTEM SUPPLIER. NOTE 2
L53100	1	(10)#12, (5)#12-G	(E) PANEL E	HH-P53	53-E-01	NOTE 2
L53101	3/4	(2)#12, (1)#12-G	HH-P53	BIOSOLIDS AREA LTG; CKT 31	53-E-01	FROM (E) PANEL E VIA L53100. NOTE 2
L53102	3/4	(2)#12, (1)#12-G	HH-P53	BIOSOLIDS AREA LTG; CKT 33	53-E-01	FROM (E) PANEL E VIA L53100. NOTE 2
L53103	3/4	(2)#12, (1)#12-G	HH-P53	BIOSOLIDS AREA LTG; CKT 24	53-E-01	FROM (E) PANEL E VIA L53100. NOTE 2
L53104	3/4	(2)#12, (1)#12-G	HH-P53	BIOSOLIDS AREA RECEP; CKT 35	53-E-01	FROM (E) PANEL E VIA L53100. NOTE 2
L53105	3/4	(2)#12, (1)#12-G	HH-P53	ROADWAY LTG; CKT 28	53-E-01	FROM (E) PANEL E VIA L53100. NOTE 2
SX53001	2	PULL ROPE	HH-S53	HH-S40	E-06	NOTE 2
C61101	1 1/4	(16)#14-C	(E) 43-CP-01	61-ASD-03-SE	40-E-01	
C61101A	1 1/4	(16)#14-C	61-ASD-03-SE	(E) 61-LP-01	60-E-01	REUSE EXISTING CONDUIT
N61101	3/4	(1)Cat6-C	61-ASD-03-SE	(E) 43-CP-01	40-E-01	
P61101	1 1/2	(3)#4, (1)#6-G	DPC1	61-ASD-03-SE	40-E-01	REUSE EXISTING CONDUIT
P61101A	1 1/2	(3)#4, (2)#14-C, (1)#6-G	61-ASD-03-SE	61-P-03-SE	60-E-01	REUSE EXISTING CONDUIT
S61101	1 1/4	(2)TSP-C	(E) 43-CP-01	61-ASD-03-SE	40-E-01	
S61101A	1 1/4	(1)TSP-C, (1)TST-C	61-ASD-03-SE	(E) 61-LP-01	60-E-01	REUSE EXISTING CONDUIT
C62100A	2	(28)#14-C, (6)#14-S	(E) 43-CP-01	PB-P60	60-E-01	
C62100B	2	(28)#14-C, (6)#14-S	(E) 43-CP-01	PB-P60	60-E-01	
C62101	1 1/4	(12)#14-C	PB-P60	62-G-03-FE	60-E-01	TO (E) 43-CP-01 VIA C62100A
C62102	1 1/4	(12)#14-C	PB-P60	62-G-05-FEF	60-E-01	TO (E) 43-CP-01 VIA C62100A
C62103	1 1/4	(12)#14-C	PB-P60	62-G-06-FEF	60-E-01	TO (E) 43-CP-01 VIA C62100B
C62104	1 1/4	(12)#14-C	PB-P60	62-G-08-FEF	60-E-01	TO (E) 43-CP-01 VIA C62100B
C62105	3/4	(2)#14-C	PB-P60	62-FSH-K10	60-E-01	TO (E) 43-CP-01 VIA C62100A
C62107	3/4	(2)#14-C	PB-P60	62-FSH-K21	60-E-01	TO (E) 43-CP-01 VIA C62100A
C62109	3/4	(2)#14-C	PB-P60	62-FSH-K22	60-E-01	TO (E) 43-CP-01 VIA C62100B
C62111	3/4	(2)#14-C	PB-P60	62-FSH-K23	60-E-01	TO (E) 43-CP-01 VIA C62100B
L62110	1 1/4	(6)#12, (2)#12-G	(E) PANEL E	PB-P60	60-E-01	
L62111	3/4	(2)#12, (1)#12-G	PB-P60	62-P-06-SA	60-E-01	FROM (E) PANEL E VIA L62110
L62112	3/4	(2)#12, (1)#12-G	PB-P60	62-P-07-SA	60-E-01	FROM (E) PANEL E VIA L62110
L62113	3/4	(2)#12, (1)#12-G	PB-P60	62-P-08-SA	60-E-01	FROM (E) PANEL E VIA L62110
P62101	1	(3)#10, (1)#10-G	DPC1	62-G-03-FE	60-E-01	
P62102	1	(3)#10, (1)#10-G	DPC1	62-G-05-FEF	60-E-01	
P62103	1	(3)#10, (1)#10-G	DPC1	62-G-06-FEF	60-E-01	

Conduit Tag	Size [in.]	Fill	From	To	Dwg Ref.	Comments
P62104	1	(3)#10, (1)#10-G	DPC1	62-G-08-FEF	60-E-01	
L64012	3/4	(2)#12, (1)#12-G	(E) POWER J BOX	63-AE/AIT-K4-3	64-E-01	TO 64-CP-01 VIA (E) CONDUIT AND WIRE
S64011H	3/4	(1)TSP-C	(E) SIGNAL J BOX	63-AE/AIT-K4-2	64-E-01	REUSE EXISTING CONDUIT. TO 64 CP-01 VIA (E) CONDUIT AND WIRE
S64012	3/4	(1)TSP-C	(E) SIGNAL J BOX	63-AE/AIT-K4-3	64-E-01	TO 64-CP-01 VIA (E) CONDUIT AND WIRE
FO80001	2	(3) 12 FO CABLES	52-CP-01	(E) 80-CP-01	80-E-01	NOTE 1

NOTES

1. WORK IS INCLUDED AS PART OF SCHEDULES C, D AND E AND SHALL NOT BE PERFORMED IF THOSE SCHEDULES ARE NOT SELECTED. REFER TO SPECIFICATION SECTION 01025 – MEASUREMENT AND PAYMENT FOR ADDITIONAL DETAIL ON BID SCHEDULES.

2. WORK IS INCLUDED AS PART OF SCHEDULES D AND E AND SHALL NOT BE PERFORMED IF THOSE SCHEDULES ARE NOT SELECTED. REFER TO SPECIFICATION SECTION 01025 – MEASUREMENT AND PAYMENT FOR ADDITIONAL DETAIL ON BID SCHEDULES.

SECTION 16140 – WIRING DEVICES - POWER AND DISTRIBUTION

PART 1 GENERAL

1.1 DESCRIPTION

A. Work included:

1. Furnish all labor, materials, and equipment and install wiring devices as shown on the Drawings and as specified herein.

2. Provide all interconnecting conduit and branch circuit wiring for receptacle circuits in accordance with the NEC.

1.2 RELATED SECTIONS:

A. Section 16000 – Common Work Results for Electrical

B. Section 16130 – Raceway and Boxes

C. Section 16500 – Lighting Systems

1.3 SUBMITTALS

A. Submittals shall be in accordance with Section 01340 and 16000.

B. Submit annotated catalog cuts for all wiring devices provided under this contract. Annotation shall indicate the specific product type, rating, and application for each device provided.

1.4 REFERENCE STANDARDS

A. Wiring devices shall comply with the requirements of the 2007 California Electrical Code (NEC).

B. Federal Specifications (FS)

1. FS WS 896: Switches, Toggle (Toggle and Lock), Flush Mounted General Specification

2. FS WC 596: Connector, Electrical Power, General Specification For

C. American National Standards Institute (ANSI)/National Electrical Manufacturer's Association (NEMA)

1. ANSI/NEMA WD1: General Color Requirements for Wiring Devices

2. ANSI/NEMA WD6: Wiring Devices/Dimensional Requirements

D. American Society for Testing and Materials (ASTM)

1. ASTM A193: Standard Specification for Alloy-Steel and Stainless Steel Bolting Materials for High Temperature or High Pressure Service and Other Special Purpose Applications

E. Underwriters Laboratories (UL)

1. UL 20: General Use Snap Switches

2. UL 498: Attachment Plugs and Receptacles

3. UL 514A: Metallic Outlet Boxes

4. UL 514C: Standard for Nonmetallic Outlet Boxes, Flush-Device Boxes, and Covers

5. UL 943: Ground-Fault Circuit-Interrupters

6. UL 1449: Surge Protection Devices

F. Where reference is made to one of the above standards, the revision in effect at the time of bid opening shall apply.

PART 2 PRODUCTS

2.1 MATERIALS

A. Wall Switches

1. Switches shall be heavy duty, industrial specification grade, toggle action, flush mounting quiet type with ground screw terminal. Provide switches in conformance with NEMA WD1, FS WS-896, and UL 20.

2. Provide 1-pole switches unless multi-pole switches are shown on the Drawings or if required to achieve the lighting control requirements indicated.

3. Toggle switch shall be ivory color.

4. Rating shall be 20A, 120/277 Volt with maintained contacts. Where shown on the Drawings provide momentary contact, 3-position, 2-circuit with center off style switches for application with lighting contactors as specified in Section 16500.

5. Provide switches with back and side wire terminals accepting up to #10 AWG stranded or solid conductors. Provide grounding screw terminal.

6. Acceptable manufacturers:

a. Cooper Wiring Devices, Inc. type E-1

b. Hubbell, Inc.

c. Approved equal

B. Duplex Receptacles – General Purpose Type

1. Duplex receptacles shall be, industrial specification grade, straight blade, 2 pole, 3 wire grounding type with contact made on two sides of the inserted blade. Provide in conformance with ANSI/NEMA WD1, FS WC 596, and UL 498. Provide isolated ground type where shown on the Drawings.

2. Rating shall be 20A, 125Volt.

3. High impact and chemical resistant nylon face. Provide corrosion resistant marine duty type where located in NEMA 3R, NEMA 4, or NEMA 4X locations as shown on the Drawings and in conformance with Section 16000. Provide face color ivory for standard applications; orange face for isolated ground applications; red face when powered from emergency or uninterruptible power sources.

4. NEMA configuration 5-20R per ANSI/NEMA WD6.

5. Acceptable manufactures:

   a. Cooper Wiring Devices, Inc. type G-7; type G-9 for isolated ground applications; type M-1 for corrosion resistant, marine grade units.

   b. Hubbell, Inc.

   c. Approved equal

C. Duplex Receptacles - Ground Fault Circuit Interrupter (GFCI) Type

1. Provide GFCI type, industrial specification grade, 20 Amp, 125 Volt, 2 Pole, 3 Wire, feed thru type with "test" and "reset" buttons in conformance with UL 943. Units shall trip at 5mA.

2. Provide corrosion resistant marine duty type where located in NEMA 3R, NEMA 4, or NEMA 4X locations as shown on the Drawings and in conformance with Section 16000.

3. NEMA 5-20R configuration per ANSI/NEMA WD6. Units shall fit standard size boxes and be compatible with standard device plates.

4. Acceptable Manufactures:

   a. Cooper Wiring Devices, Inc. type GFCI

   b. Hubbell, Inc.

   c. Approved equal

D. Duplex Receptacles – Surge Suppression Type

1. Provide transient voltage surge suppression (TVSS) type receptacles where shown on the Drawings. Provide 20A, 125Volt, 2 Pole, 3 Wire grounding type in NEMA 5-20R configuration, hospital grade conforming to UL 1449.

2. Provide hot to neutral and hot to ground surge protection with clamping voltage of 400 Volts maximum and providing a minimum of 280 Joules of surge protection in each mode.

3. Provide units having visual indication of the functionalities of the TVSS receptacle. Units shall have an audio alarm indication upon loss of ground or when surge protection is no longer functioning. Audio alarm shall include a front accessible alarm mute function.

4. Acceptable manufacturers:

   a. Cooper Wiring Devices, Inc. Type J1

   b. Hubbell

   c. Approved equal

E. Multi-Outlet Raceway Assemblies

1. Provide surface mounted raceway, multi-outlet wiring system for branch circuit wiring and high density convenience receptacle installations where shown on the Drawings.

2. Provide units in standard manufactured lengths. Units shall be of two piece design with removable cover made of manufactured steel. Base units shall have ½" trade knockouts for and covers shall have blank or prepunched cuts for receptacle installation on uniform centers.

3. Provide laboratory specification grade receptacle. Rating shall be 15A, 125 Volt, NEMA configuration 5-15R and conforming to UL 498.

4. Provide multi-outlet raceway systems with factory wired receptacles. Each receptacle shall be in an isolated ground configuration.

5. Assemblies shall be installed and configured using manufacturer's standard mounting hardware, connectors, and fittings. Unit color shall be field coordinated with the installation and suitable for field repainting.

6. Provide two piece multichannel configuration for multiple system usage where shown on the Drawings.

7. Acceptable manufacturers:

   a. Wiremold (subsidiary of Legrand), Plugmold Systems Series 2000 (single channel) or Series 4000 (multichannel) as required.

   b. Hubbell

   c. Approved equal

F. Device Plates

1. Plates for indoor flush mounted devices shall be of the required number of gangs for the application involved and shall be applied where shown on the Drawings and per Section 16000 as follows:

   a. NEMA 1 (Finished) Areas: Smooth, high impact nylon of the same manufacturer and color (ivory) as the device.

   b. NEMA 4X, 4, and 12 (Indoor Process) Areas: Stainless steel, brushed with stainless steel mounting screws.

2. Plates for devices surface mounted outdoors shall be weatherproof.

   a. Weatherproof receptacles shall have a gasketed weatherproof coverplate. Mounting screws shall be Type 304 stainless steel.

   b. Weatherproof switches shall have a gasketed, weatherproof, cast metal cover plate incorporating an external operator for the internal switch. Mounting screws shall be Type 304 stainless steel in accordance with ASTM A193.

3. Unless otherwise specified, plates for device boxes shall be of the same material as the box (metallic or non-metallic) per Section 16130.

4. Multiple surface mounted devices shall be ganged in a single, common box and provided with an adapter, if necessary, to allow mounting of single gang device plates on multigang cast boxes.

5. Engraved device plates shall be provided where required.

6. Plates shall be by the same manufacturer of the devices to which they are applied.

7. Weatherproof Protective Boot

   a. Provide UL Listed weather protective boots over plug ends of cord connected equipment located in NEMA 3R, NEMA 4, and NEMA 4X locations. Industrial specification grade UL listed for wet locations with self closing spring door and gasketing.

8. Suitable for single and duplex receptacles

   a. Cover manufactured by same manufacture of receptacle. Provide protective boots having neoprene covers and suitable for application on 120V, 3 Wire, 20 A devices. Provide protective boots as manufactured by Cooper Wiring Devices, Inc, type BS-1 or approved equal.

9. Weatherproof "Constant Use" Cover

   a. UL listed single or two gang box cover made of polycarbonate, vertical arrangement.

b. Acceptable manufactures:

1) Crouse-Hinds

2) Approved equal

PART 3 EXECUTION

3.1 INSTALLATION

A. The locations of devices are shown diagrammatically on the Drawings and may be varied within reasonable limits so as to avoid piping, equipment, or other obstruction. Coordinate the final installation location of the devices with piping and equipment clearances and to conform to the requirements of the NEC. Any such relocation of wiring device locations shall be coordinated with the Owner and shall be performed at no addition to the Contract bid price.

B. Devices shall be installed in conformance with manufacturer's recommendations. Manufacturer's recommended fittings and hardware shall be used in all cases.

C. Faces of switches and receptacles shall be installed flush with the finished wall surfaces in NEMA 1 areas shown on the Drawings. Lighting switches shall be installed on the lock side of doors.

D. Devices installed in areas designated NEMA 3R, 12, 4, or 4X on the Drawings shall be surface mounted.

E. Provide weatherproof device covers for all wiring devices installed in areas designated NEMA 3R, NEMA 4, or NEMA 4X on the Drawings and per Section 16000.

F. Provide "Constant Use" covers for receptacles used for cord connected mechanical equipment operated near water sources that are connected by means of a plug into a receptacle outlet such as sump pumps, sample pumps, analyzers, etc.

G. Mount receptacles as follows unless noted otherwise on the drawings:

1. 12-inches above the finished floor in NEMA 1 areas

2. 48-inches above the finished floor or grade in below grade vaults, structures, and other process areas rated NEMA 4 or NEMA 4X.

3. 18-inches above the finished floor in NEMA 12 areas

H. Device Plates

1. Plates shall fit closely and tightly to the box on which they are installed.

2. Plates on surface-mounted boxes shall not extend beyond the sides of the box unless the plates do not have sharp corners or edges.

3. The plate material shall be compatible with the box material to prevent galvanic corrosion.

4. Oversized plates shall be installed where standard plates do not fully cover the wall opening.

I. GFCI Installation

1. Use of feed-through circuiting may be used where ground-fault circuit protection is required for groups of receptacles.

2. For applications with heat trace heating tape, provide GFCI protected breakers having adjustable sensitivity trip setting as specified per Section 16440. The use of GFCI receptacles for these applications is not acceptable.

END OF SECTION

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SECTION 16145 – MISCELLANEOUS ELECTRICAL EQUIPMENT

PART 1 GENERAL

1.1 SCOPE OF WORK

A. All miscellaneous electrical equipment as shown on the Drawings and as specified in these Specifications.

B. This Section provides the requirements for miscellaneous equipment typically employed in a facility; however, not all components specified in this Section are necessarily utilized on this Project.

C. The following equipment is included under this Section:

1. Disconnect switches
2. Enclosed combination magnetic motor starters
3. Manual motor starters
4. Control stations
5. Rotating alarm beacons
6. Corrosion inhibitors
7. Insulating rubber floor mats
8. Equipment mounting stands
9. Termination cabinets
10. Manual transfer switches

1.2 RELATED SECTIONS

A. Section 16000 – Common Work Results for Electrical

B. Section 16062 – Grounding System

1.3 SUBMITTALS

A. Submittals shall be in accordance with Section 01340 and Section 16000. Submittals shall contain detailed catalog information or drawings describing electrical and physical characteristics of all equipment specified.

1.4 REFERENCE STANDARDS

A. Equipment enclosures shall have NEMA ratings suitable for the location in which they are installed, as specified in Section 16001.

B. Underwriters Laboratories (UL):

1. UL 1008 – Automatic Transfer Switches.

C. National Fire Protection Association (NFPA):

1. NFPA 110 – Standard for Emergency and Standby Power Systems.

2. NFPA 70 – National Electrical Code

D. Institute of Electronic and Electrical Engineers:

1. IEEE 446 – Recommended Practice for Emergency and Standby Power Systems.

E. National Electrical Manufacturers Association

1. NEMA – AC Automatic Transfer Switch Equipment.

PART 2 PRODUCTS

2.1 DISCONNECT SWITCHES

A. Disconnect switches shall be heavy-duty, horsepower rated, quick-make, quick-break, visible blades, 600 Volt, 3 Pole with full cover interlock, interlock defeat and flange mounted operating handle. Switches shall be 6 pole for 2-speed devices.

B. Provide disconnect switch with current ratings as shown on the Drawings, 30 Amperes minimum. Provide fused type where shown on the Drawings.

C. Switch assembly and operating handle shall be integral with the enclosure base. Provide means for padlocking disconnect switch in the OFF position using standard 3/8-inch shank locks.

D. Provide switches UL Listed as Service Entrance equipment where shown on the Drawings.

E. NEMA 1 and NEMA 3R switch enclosures shall be factory painted steel, ANSI 61 gray

F. NEMA 4 enclosures shall be 316 stainless steel.

G. NEMA 4X enclosures shall be high impact strength fiberglass reinforced polyester.

H. Switches shall be as manufactured by the Eaton Corporation Heavy Duty Safety Switches; Square D Co.; General Electric; or equal.

2.2 ENCLOSED COMBINATION MAGNETIC MOTOR STARTERS

A. Motor starters shall consist of combination motor circuit protector and contactor, 2 or 3 Pole, single or 3 Phase as required for the indicated applciation, 60 Hz, 600 Volt, magnetically operated, full voltage non-reversing unless otherwise shown on the Drawings. NEMA sizes shall be as required for the horsepowers shown on the Drawings. Minimum size shall be NEMA size 1.

B. Motor circuit protectors shall be molded case with adjustable magnetic trip only. They shall be specifically designed for use with magnetic motor starters. Motor circuit protectors shall be current limiting type, with additional current limiters if required. Combination motor starters shall be fully rated for 22,000 Amps RMS symmetrical.

C. Multi-speed and reversing starters shall include two motor rated contactors mechanically and electrically interlocked so that only one device may be energized at any time.

D. Each motor starter shall have a 120 Volt operating coil and control power transformer. Transformer primaries and secondaries shall be equipped with time-delay fuses. Three phase starters shall have three overload relays. One normally open and one normally closed auxiliary RUN contact shall be provided as spares in addition to contacts shown on the Drawings.

E. Overload relays shall be adjustable, ambient compensated and manually reset.

F. Enclosures: Provide combination starters factory installed within NEMA rated enclosures. Provide integral built-in control stations, indicating lights, and overload RESET button on the enclosure front where shown on the Drawings.

1. NEMA 12 or 4 enclosures shall be painted steel.

2. NEMA 4X enclosures shall be stainless steel.

3. NEMA 7 enclosures shall be cast aluminum.

G. Enclosed combination magnetic motor starters shall be as manufactured by the Square D Co.; General Electric; Cutler-Hammer, or equal.

2.3 MANUAL MOTOR STARTERS

A. Manual starters shall be suitable for the voltage and number of phase shown on the Drawings and shall be non-reversing, reversing or two speed type as shown on the Drawings. NEMA sizes shall be as required for the horsepowers shown on the Drawings. Manual starters shall have motor overload protection in each phase when used as motor disconnect switches; overload protection is not required when used for device or instrumentation disconnects as specified under Section 13410.

B. NEMA 1 and NEMA 3R switch enclosures shall be factory painted steel, ANSI 61 gray

C. NEMA 4 enclosures shall be 316 stainless steel.

D. NEMA 4X enclosures shall be high impact strength fiberglass reinforced polyester.

E. Manual motor starters shall be as manufactured by the Eaton Corporation; Square D Co.; General Electric; or equal.

2.4 CONTROL STATIONS

A. Control stations shall be heavy-duty or industrial-duty type, sized to accommodate full size operators (30mm) as specified under Section 13420.

B. Control station operators noted for use as local emergency stop (LES) on the Drawings shall be maintained contact, push to stop/pull to release type.

C. Provide control stations sized for the number and type of pilot devices as shown on the Drawings. Control station dimensions shall be adequate to accommodate device contact blocks and a minimum of one additional auxiliary contact block for remote monitoring of pilot operator positions.

D. Provide permanent engraved escutcheon plates for all devices labled with the specific functions as shown on the Drawings or as specified (e.g., RUN, HAND-OFF-AUTO)

E. NEMA 1 and NEMA 3R switch enclosures shall be factory painted steel, ANSI 61 gray

F. NEMA 4 enclosures shall be 316 stainless steel.

G. NEMA 4X enclosures shall be high impact strength fiberglass reinforced polyester.

H. Control stations shall be by General Electric Co.; Eaton Corporation; Square D; or equal.

2.5 ROTATING ALARM BEACONS

A. Provide compact rotating alarm indicator beacons with red color lens. Beacons shall have a nominal diameter of 9-inches.

B. Provide NEMA 4X units suitable for outdoor installation with LEDs, reflector, and motor sealed in a polycarbonate dome; operating temperature up to 150° F.

C. Lighting units shall be UL Listed, with LED sources having a minimum 50,000-hour life.

D. Beacon base shall be suitable for surface or pipe mounting using nominal ½” NPT.

E. Provide rotating beacon powered from 120VAC, with 12 light LED array, high intensity reflector, and 360° beam rotation.

F. Provide rotating alarm beacon as manufactured by Federal Signal Corporation, model 371LED Commander; Edwards Signal; or equal.

2.6 CORROSION INHIBITORS

A. All equipment enclosures, terminal boxes, etc, located in a corrosive rated area (where shown on the Drawings) that contains electrical or electronic equipment or terminal strips shall be furnished with an internally mounted, chemically treated corrosion inhibitor pad.

B. The corrosion inhibitor pads shall be as manufactured by Hoffman Engineering Co.; 3M or equal.

2.7 INSULATING RUBBER FLOOR MATS

A. Furnish and install a non-conductive elastomer compound rubber floor mat extending the full length and placed in front of and in back of each indoor or walk-in 22 kV switchgear and each indoor or walk-in 480 volt switchgear, motor control center or other enclosure provided under this Contract.

B. Mats shall be in accordance with ASTM D178 specification, Type II, ozone, flame and oil resistant, 36-in wide with corrugated surface and shall be branded continuously on the back.

C. 480V applications: Class 1, 3/16-in thick minimum

1. Maximum Use Voltage phase to phase: 7,000 V

2. AC Proof – Dielectric Test Voltage: 20,000 V

D. 22 kV applications: Class 3, 3/8-in thick minimum

1. Maximum Use Voltage phase to phase: 26,500 V

2. AC Proof - Dielectric Test Voltage: 40,000 V

E. Mats shall be stored without distortion, free from direct sun light or sources of ozone and at a temperature not to exceed 95 degrees F (35 degrees C).

F. Provide insulating rubber floor mats by The Mat King, or equal.

2.8 EQUIPMENT MOUNTING STANDS

A. Equipment mounting stands shall be custom fabricated from steel plate and steel supports, as shown on the Drawings.

B. Steel plates and supports shall be hot dip galvanized after fabrication.

2.9 TERMINATION CABINETS

A. All interiors shall be completely factory or shop assembled with terminal blocks and insulating barriers. All 120 volt AC and DC terminal blocks shall be isolated from each other by insulating barriers or separate enclosures. Interiors shall be designed so that terminal blocks or control relays can be replaced or added without disturbing adjacent units.

B. All wiring carrying signals and voltages of a similar type shall be grouped together within the cabinets in harnesses and secured to the structure.

C. All shielded cables shall terminate in separate cabinets. A third terminal shall be provided for each twisted shield pair and the shield for each connected thereto, unless otherwise noted on manufacturer's shop drawings.

D. Terminal blocks shall be molded plastic, tubular screw type with pressure plates and shall be rated 600 volts. Terminals shall be double sided and supplied with removable covers. Each cabinet shall be furnished with a minimum of 50 spare terminals. Terminal blocks shall be Allen Bradley; ABB; Kukla, or equal.

E. Boxes shall be made from 14 gauge galvanized steel and shall be of sufficient size to provide a minimum of 6-in of wiring space on all sides and between adjacent terminal blocks. Boxes in wet, damp, corrosive and all outdoor locations shall be NEMA 4X, Type 316 stainless steel. A minimum of four mounting studs shall be provided on each cabinet. Cabinets shall be furnished without knockouts. Holes for raceways shall be drilled on the job coordinated with incoming conduits.

F. A single hinged door shall cover the front of each terminal cabinet. Doors shall have a neoprene gasket, vault type handle, three point hatch and lock. Two keys shall be supplied for each lock. All locks shall be keyed alike. A terminal block schedule shall be provided with each terminal point numbered and identified (typewritten) as to function.

G. All exterior and interior steel surfaces of the cabinets shall be properly cleaned and finished with white over a rust-inhibiting phosphatized coating conforming to ANSI A55.1. The finish paint shall be of a type to which field applied paint will adhere.

H. Cabinet enclosures shall be as manufactured by Hoffman Engineering Company; Hennessy Products; Lee, or equal, with latch kit hardware.

2.10 MANUAL TRANSFER SWITCH

A. The switch shall be rated, and UL listed for emergency use and be open transition type, with electrical ratings and number of sources as shown on the Drawings.

1. Capable of switching all classes of load and rated for continuous duty when installed in a non-ventilated enclosure.

2. 6-cycle or less closing and withstand current rating: 35,000 amperes RMS minimum.

a. The withstand current rating shall be time-based or coordinated with the protective upstream circuit-breakers. Contractor shall field investigate existing circuit breakers as required.

3. Where indicated as a 4 Pole switch on the drawings, provide a switched neutral. Otherwise provide a solid neutral.

4. Switch shall be factory installed in a wall-mountable enclosure matching the NEMA Type rating as shown on the Drawings. Enclosures shown in NEMA Type 3R or 4X areas shall be constructed of 316 stainless steel. Enclosure shall meet typical control panel enclosure construction specifications listed under Section 13420.

5. Complete with all accessories; Nameplate with Standard UL-1008 listing acceptable for use on emergency systems or life safety systems.

6. Double throw, actuated by 2 electrical operators, momentarily energized and connected to a simple over-center linkage.

a. Minimum transfer time of 400 milliseconds. Provide adjustable transfer time delay, 1-300 seconds factory set at 3 seconds.

b. Switches shall be capable of transferring successfully in either direction with 70 percent of rated voltage applied to the terminals.

7. The time delay between the opening of the closed contacts and the closing of the open contacts shall allow for voltage decay before transfer, allowing the motor and transformer loads to be re-energized after transfer with normal in-rush current.

8. Normal and Emergency Contacts: Positively interlocked mechanically and electrically to prevent simultaneous closing.

    a. Main contacts shall be of silver-tungsten alloy, mechanically locked in position without the use of hooks, latches, or magnets.

    b. Provide separate arcing contacts with magnetic blowouts on each pole.

9. Equip transfer switch with a permanently attached, safe, manual operator designed to prevent injury to personnel in the event the electrical operator should become energized during manual transfer.

    a. Manual operator shall provide the same contact-to-contact transfer speed as the electrical operator to prevent a flashover from slowly switching the main contacts.

10. Switches: Capable of normal operation during and after seismic loading. Seismic loading shall not cause false operation.

B. Relays, timers, control wiring, and accessories shall be front accessible.

C. Identify control wire terminations by tubular sleeve-type markers at both ends in accordance with the approved shop drawings.

D. Provide control relays, timers, terminal blocks, wiring, and similar equipment in accordance with the relevant individual specification sections of this contract.

E. Accessories:

1. Provide manual transfer switch with the following features:

    a. For each switch position, provide 2 auxiliary contacts rated 15 amperes at 120 VAC.

    b. Pilot lights to indicate switch position.

2. For manual transfer switches located in exposed outdoor locations, protect the transfer switch HMI and pilot devices from vandalism behind a lockable transparent window. The lockable window cover shall match the NEMA Type rating and material of the transfer switch enclosure.

F. Acceptable Manufacturers:

1. Subject to compliance with these specifications, the typical equipment, systems and accessories installed shall be manufactured by:

    a. GE (ABB Industrial), Zenith, ZTS Series.

    b. Emerson, Vertiv ASCO 300 Series.

    c. Approved equal.

PART 3 EXECUTION

3.1 INSTALLATION

A. Rubber Floor Mats

1. Install mats in one continuous piece in front of the entire length of the switchgear, switchboard, or other equipment as specified. Extend mat length 1 foot beyond the end of the equipment up to any fixed or structural obstruction.

2. Where equipment faces each other and is less than 6-ft apart, provide one width of mat across the entire width of the aisle-way between the equipment faces.

B. Mounting Stands

1. Field mounted disconnects, pushbutton control stations, etc., shall be mounted on steel stands as shown on the Drawings. Where clearance requirements for stands may not be maintained, the Construction Manager may direct equipment to be wall-mounted adjacent to the equipment, but in no case shall the distance from the equipment to the control station exceed 3-ft.

END OF SECTION

SECTION 16220 – LOW VOLTAGE MOTORS

PART 1 GENERAL

1.1 SCOPE OF WORK

A. Provide three-phase and single-phase AC induction motors 600V or less, rated 500HP or less and operating at greater than 75% load for equipment as shown on the Contract Documents.

B. Provide all motor accessories, features, and enclosures as specified herein.

C. Motors furnished under other Sections, shall be in conformance with the requirements listed in this Section unless otherwise noted in the detailed technical specifications included in Division 11 and 15.

1.2 RELATED SECTIONS

A. Section 16000 – Electrical and Instrumentation General Provisions

B. Section 16060 – Grounding and Bonding for Electrical Systems

1.3 SUBMITTALS

A. Submittals shall be in accordance with Sections 01340 and 16000.

B. Submittal of motor data shall include complete nameplate data and test characteristics in accordance with NEMA Standard MG1 Part 12 and, in addition, the following for motors typical of the units furnished:

1. Efficiency at 1/2, 3/4 and full load
2. Power factor at 1/2, 3/4 and full load
3. Motor outline, dimensions and weight
4. Descriptive bulletins, including full description of insulation system
5. Bearing design data
6. Special features (i.e., space heaters, temperature detectors, etc.)
7. Dimensional drawings for each item of couplings and motor to be furnished for motors to be replaced under this Contract

C. Submit method and equipment for grounding shaft rotors for motors powered by PWM variable frequency drives.

D. For inverter duty rated motors, provide certification that the motor is in compliance with NEMA MG-1, Part 31.

1.4 REFERENCE STANDARDS

A. Institute of Electrical and Electronics Engineers (IEEE):

1. IEEE 43: IEEE Recommended Practice for Testing Insulation Resistance of Rotating Machinery

2. IEEE 841: IEEE Standard for Petroleum and Chemical Industry – Severe Duty Totally Enclosed Fan-Cooled (TEFC) Squirrel Cage Induction Motors – Up To and Including 370 KW (500 HP).

3. IEEE 112: Standard Test Procedure for Polyphase Induction Motors and Generators.

4. IEEE 114: Standard Test Procedures for Single-Phase Induction Motors.

B. National Electrical Manufacturers Association (NEMA):

1. NEMA MG1: Motors and Generators

C. American Bearing Manufacturers Association (ABMA)

1. ABMA 20: Radial Bearings of Ball, Cylindrical Roller, and Spherical Roller Types – Metric Design

1.5 QUALITY ASSURANCE

A. Where motors are specified under the technical specifications as “Severe Duty” they shall be designed and manufactured in accordance with the latest version of IEEE Standard 841.

B. Unless noted otherwise herein, routine tests shall be performed on representative motors in accordance with IEEE Standard 112, and shall include the information described in NEMA MG1-Part 12 and manufacture’s standard testing. Efficiency shall be determined in accordance with IEEE Publication No. 112, Method B. Power factor shall be measured on representative motors. Certification shall be provided that motors have passed the factory tests.

PART 2 PRODUCTS

2.1 RATING

A. Each motor shall develop ample torque for its required service throughout its acceleration range at a voltage 10 percent below nameplate rating. Where shown on the Drawings to be operated on a reduced voltage starter, the motor shall develop ample torque under the conditions imposed by the reduced voltage starting method.

B. All motors shall be rated for continuous duty suitable for operation in a 40 degrees C ambient and not less than minus 15 degrees C with altitudes less than 1,000 meters unless otherwise noted.

C. Motors shall be rated for frequency variation within plus/minus 5%.

D. Specific motor data such as HP, rpm, enclosure type, etc., are specified under the detailed specification for the equipment with which the motor is supplied.

E. Provide motors 1 horsepower and above with service factor of 1.15 at 40°C under sinusoidal operation unless specifically noted otherwise.

F. Motors specified for operation under variable frequency drives shall be inverter duty rated in compliance with NEMA MG-1, Part 31 and shall have a nameplate service factor of 1.15 (sinusoidal operation) and 1.0 when driven from a non-sinusoidal source.

2.2 ENCLOSURES

A. Motors specified herein will conform to one of the following NEMA standard enclosure designs:

1. Open Drip Proof (ODP): Motor shall be constructed with ventilated openings such that drops of liquid and solid particles striking or entering the enclosure at any angle 0–15 degrees downward from vertical do not interfere with the successful operation of the motor.

2. Weather Protected Type I (WPI): A weather-protected Type I machine is a guarded machine with its ventilating passages so constructed as to minimize the entrance of rain, snow and air-borne particles to the electric parts.

3. Weather Protected Type II (WPII): A weather-protected Type II machine shall have, in addition to the enclosure defined for a weather protected Type I machine, its ventilating passages at both intake and discharge so arranged that high velocity air and air-borne particles blown into the machine by storms or high winds can be discharged without entering the internal ventilating passages leading directly to the electric parts of the machine itself. The normal path of the ventilating air which enters the electric parts of the machine shall be so arranged by baffling or separate housings as to provide at least three abrupt changes in direction, none of which shall be less than 90 degrees. In addition, an area of low velocity not exceeding 600 feet per minute shall be provided in the intake.

4. Totally enclosed fan cooled (TEFC) Motors shall have a steel or cast iron frame, cast iron end brackets, cast iron conduit box, drain holes (corrosion resistant plugs for frames 286T and smaller and automatic breather/drain devices for frames 324T and larger) and upgraded insulation by additional dips and bakes to increase moisture resistance. Fan for cooling the motor shall be integral.

B. Motors shall have a steel or cast iron frame and a cast iron or stamped steel conduit box.

1. Conduit box shall be split from top to bottom and shall be capable of being rotated to four positions.

2. Synthetic rubber-like gaskets shall be provided between the frame and the conduit box and between the conduit box and its cover.

3. Where available for the enclosure type specified, motor leads shall be sealed with a non-wicking, non-hygroscopic insulating material.

4. A frame mounted pad with drilled and tapped hole, not less than 1/4-in diameter, shall be provided inside the conduit box for motor frame grounding.

2.3 SEVERE DUTY

A. Where motors are specified to be “Severe Duty” per the technical specifications they shall be of the corrosion resistant type conforming to motors designated by the manufacturer as "Corro-Duty", "Mill and Chemical", "Custom Severe Duty", or similar quality designation. Severe duty motors shall have a cast iron frame, cast iron end brackets, cast iron conduit box, tapped drain holes (corrosion resistant plug for frames 286T and smaller and automatic breather/drain devices for frames 324T and larger).

B. Motors shall be single speed, totally-enclosed fan-cooled (TEFC), squirrel-cage polyphase induction motors.

C. Where fractional horsepower motors are specified in the process equipment specifications or shown on the Drawings for applications requiring severe duty motors, provide nominal 1 horsepower severe duty motor conforming to manufacturer’s standard severe duty equipment.

2.4 SPECIAL PURPOSE MOTORS

A. Submersible motors:

1. The pump motor shall be a NEMA B design, induction type with a squirrel cage rotor, shell type design, housed in an air filled, watertight chamber. The stator windings shall be insulated with moisture resistant Class H insulation rated for 180°C (356°F). The stator shall be insulated by the trickle impregnation method using Class H monomer-free polyester resin resulting in a winding fill factor of at least 95%. The stator shall be heat-shrink fitted into the cast iron stator housing. The use of multiple step dip and bake-type stator insulation process is not acceptable. The use of pins, bolts, screws or other fastening devices used to locate or hold the stator and that penetrate the stator housing are not acceptable. The motor shall be designed for continuous duty while handling pumped media of up to 104°F. The motor shall be capable of no less than 15 evenly spaced starts per hour. The rotor bars and short circuit rings shall be made of aluminum.

2. Three thermal switches shall be embedded in the stator end coils, one per phase winding, to monitor the stator temperature. These thermal switches shall be used in conjunction with and supplemental to external motor overload protection.

3. The motor shall include a moisture sensor that will detect when moisture has entered the stator and lower oil seal housing. The sensor shall send an alarm to a control panel, motor control center or as shown on the drawings.

4. The power and control cable entry shall be designed to provide a positive leak-free seal to prevent liquid from entering the air filled motor housing. Cable type shall be SEOW-A or Equal and be UL Listed for submersible use in sewage water.

5. The junction chamber shall be sealed off from the stator housing and shall contain a terminal board for connection of power and pilot sensor cables using threaded compression type terminals. The use of wire nuts or crimp-type connectors is not acceptable.

6. Where shown on the Drawings or where specified, the motor shall be explosion proof, TENV design and be certified for Class 1, Division 1, Groups C & D by Factory Mutual (FM).

B. Explosion proof motors

1. Explosion proof motors shall have a cast iron frame, cast iron end brackets, cast iron conduit box, 1.15 service factor at 40 degrees C, tapped drain holes (corrosion resistant plugs for frames 286T and smaller and automatic breather/drain devices for frames 324T and larger) and be UL listed for Class 1, Div. 1, Group D hazardous areas.

2.5 NAMEPLATES

A. Provide motor manufacturer's nameplates engraved or embossed on stainless steel and fastened to the motor frame with stainless steel screws or drive pins. Nameplates shall indicate clearly all of the items of information enumerated in NEMA Standard MG1-10.38 or MG1-20.60, as applicable.

2.6 CONDENSATION HEATERS

A. Provide condensation winding space heaters for every 3-phase motor provided under this Contract unless specified otherwise under the detailed equipment specifications. Heaters shall be of the cartridge or flexible wrap around type installed within the motor enclosure adjacent to core iron. Heaters shall be rated for 120 Volt, single phase with wattage as required or as recommended by the motor manufacturer for the specific application. The heater wattage and voltage shall be embossed on the motor nameplate. Power leads for heaters shall be brought out at the motor lead junction box or auxiliary termination box if available.

2.7 TEMPERATURE DETECTORS

A. Provide stator winding temperature detectors for all motors 200 hp and larger, all motors 40 hp and larger when driven by variable speed drives, where specified under the detailed mechanical specifications for individual equipment, or where shown on the Drawings.

B. Provide factory installed, embedded, bi-metallic switch type. Device shall protect the motor against damage from overheating caused by single phasing, overload, high ambient temperature, abnormal voltage, locked rotor, frequent starts or ventilation failure. The switch shall have normally closed contacts. Not less than three detectors shall be furnished with each motor.

C. Detector leads shall be terminated in the motor main conduit termination box or auxiliary termination box on the motor frame if available.

2.8 SINGLE PHASE MOTORS

A. Unless otherwise specified, motors smaller than 1/2 Hp shall be single phase, capacitor start. Small fan motors may be split-phase or shaded pole type if such are standard for the equipment. Wound rotor or commutator type single-phase motors are not acceptable unless their specific characteristics are necessary for the application.

B. Single-phase motors shall be rated for operation at 115 Volts, 208 Volts, or 240 Volts, single phase, 60 Hz, as shown on the Drawings.

C. Locked rotor current shall not be greater than specified in NEMA Standard MG1, Part 12, Design "N".

D. Motors shall be totally enclosed in conformance with NEMA Standard MG1, Part 1. Small fan motors may be open type if suitably protected from moisture, dripping water and lint accumulation.

E. Motors shall be provided with sealed ball bearings lubricated for 10 years normal use.

F. Motors shall be by Nidec-U.S. Motors; Baldor; GE Motors; or equal.

2.9 THREE PHASE MOTORS-FRAMES 143T THROUGH 449T

A. General

1. Unless otherwise specified, motors 1/2 Hp and larger shall be 3 Phase, squirrel cage induction type, premium efficiency.

2. All motors 3/4 Hp and larger shall be a NEMA frame 143T or larger. 1/2 Hp motors and 3/4 Hp motors rated 1800 and 3600 rpm, shall be a 56 frame. Motors shall be designed and connected for operation on a 480 Volt, 3 Phase, 60 Hz alternating current system. Dual voltage (230/460) rated motors are acceptable.

3. Unless otherwise required by the load, all motors shall be NEMA Design B, normal starting torque. Locked rotor kVA/Hp shall not exceed Code Letter G as described in NEMA Standard MG1-10.37 for motors 20 Hp and larger.

4. Where available for the application or where specified as severe duty in the detailed technical process equipment specifications, motors one horsepower and above shall meet or exceed the requirements of IEEE 841.

5. Motors with a 180 frame and larger shall have provisions for lifting eyes or lugs capable of a safety factor of 5.

6. Motors shall be by Nidec-U.S. Motors; Baldor; GE Motors; or equal.

B. Bearings

1. Anti-friction motor bearings shall be designed to be regreasable and initially shall be filled with grease suitable to ambient temperature of 40 degrees C. Bearings shall be AFBMA Types BC or RN, heavy duty, or shall otherwise be shown to be suitable for the intended application in terms of B-10 rating life, Class M3 or better.

2. All grease lubricated bearings, except those specified to be factory sealed and lubricated, shall be fitted with an easily accessible grease supply, flush, drain and relief fittings including an externally visible sight glass to view the oil level. Extension tubes shall be used when necessary. Grease supply fittings shall be standard hydraulic type by the Alemite Division of the Stewart-Warner Corporation.

3. Grease lubricated bearings shall be designed for electric motor use. The grease shall be capable of higher temperatures associated with electric motors and shall be compatible with Polyurea-based greases.

4. Bearings shall be rated for a minimum of 26,280 hours L-10 life at full-load direct-coupled, except vertical high thrust motors.

5. Vertical motors shall be capable of withstanding a momentary up-thrust of at least 30% of normal down-thrust.

C. Insulation

1. Insulation systems shall be Class B (130 degrees C) and shall be manufacturer's premium grade, resistant to attack by moisture, acids, alkalies and mechanical or thermal shock. Maximum temperature rise by resistance at rated HP shall not exceed Class B limits (80 degree C).

2. For motors at 1.15 Service Factor, the maximum temperature rise by resistance shall not exceed Class F limits of 115 degree C.

3. Motors for severe duty service shall have vacuum/pressure impregnated epoxy insulation for moisture resistance.

4. Insulation for inverter duty motor windings shall meet or exceed the Pulse Endurance Index for magnetic wire and shall not be injured when exposed to repeated pulse type waveforms, repetitive high voltage transients, switching frequency and rate of rise of the pulse. Class H varnish shall be used.

D. Vibration

1. Vibration shall not exceed 0.15 inch per second, unfiltered peak.

E. Grounding Motor Shafts

1. All motors operated by variable frequency drives shall be provided with shaft grounding attachment devices.

2. The shaft grounding device shall be a metallic impregnated brush installed onto the shaft rotor such that the brush contacts the rotor surface to ground out any voltage present on the shaft rotor.

3. Brush shall be bristle type and be easily removable for replacement and maintenance without having to disassemble the motor and remove the rotor.

4. Shaft grounding device shall be manufactured by Sohre, Aegis or Equal.

F. Motor Efficiencies (Three Phase Motors)

1. Motor efficiencies shall meet the requirements of the Energy Independence and Security Act (EISA) and be manufactured to meet the minimum and nominal efficiency levels per the attached tables.

2. Efficiency values shall be based on tests performed in accordance with IEEE 112, Method B. Motors with horsepower or rpm's not listed shall conform to comparable standards of construction and materials as those for listed motors.

3. Where California laws dictate higher efficiencies than those listed, the higher efficiency motors shall be furnished.

Table 12-11
NEMA Full-Load Efficiencies of Energy Efficient Motors[1]
OPEN MOTORS

	2 POLE		4 POLE		6 POLE		8 POLE	
Hp	Nominal Efficiency	Minimum Efficiency	Nominal Efficiency	Minimum Efficiency	Nominal Efficiency	Minimum Efficiency	Nominal Efficiency	Minimum Efficiency
1.0	--	--	82.5	80.0	80.0	77.0	74.0	70.0
1.5	82.5	80.0	84.0	81.5	84.0	81.5	75.5	72.0
2.0	84.0	81.5	84.0	81.5	85.5	82.5	85.5	82.5
3.0	84.0	81.5	86.5	84.0	86.5	84.0	86.5	84.0
5.0	85.5	82.5	87.5	85.5	87.5	85.5	87.5	85.5
7.5	87.5	85.5	88.5	86.5	88.5	86.5	88.5	86.5
10	88.5	86.5	89.5	87.5	90.2	88.5	89.5	87.5
15	89.5	87.5	91.0	89.5	90.2	88.5	89.5	87.5
20	90.2	88.5	91.0	89.5	91.0	89.5	90.2	88.5
25	91.0	89.5	91.7	90.2	91.7	90.2	90.2	88.5
30	91.0	89.5	92.4	91.0	92.4	91.0	91.0	89.5
40	91.7	90.2	93.0	91.7	93.0	91.7	91.0	89.5
50	92.4	91.0	93.0	91.7	93.0	91.7	91.7	90.2
60	93.0	91.7	93.6	92.4	93.6	92.4	92.4	91.0
75	93.0	91.7	94.1	93.0	93.6	92.4	93.6	92.4
100	93.0	91.7	94.1	93.0	94.1	93.0	93.6	92.4
125	93.6	92.4	94.5	93.6	94.1	93.0	93.6	92.4
150	93.6	92.4	95.0	94.1	94.5	93.6	93.6	92.4
200	94.5	93.6	95.0	94.1	94.5	93.6	93.6	92.4
250	94.5	93.6	95.4	94.5	95.4	94.5	94.5	93.6
300	95.0	94.1	95.4	94.5	95.4	94.5	--	--
350	95.0	94.1	95.4	94.5	95.4	94.5	--	--
400	95.4	94.5	95.4	94.5	--	--	--	--
450	95.8	95.0	95.8	95.0	--	--	--	--
500	95.8	95.0	95.8	95.0	--	--	--	--

Notes:

1. **Values included in the table above were taken from the NEMA Standards MG 1-2006**

Table 12-11
NEMA Full-Load Efficiencies of Energy Efficient Motors[1]
ENCLOSED MOTORS

	2 POLE		4 POLE		6 POLE		8 POLE	
Hp	Nominal Efficiency	Minimum Efficiency	Nominal Efficiency	Minimum Efficiency	Nominal Efficiency	Minimum Efficiency	Nominal Efficiency	Minimum Efficiency
1.0	75.5	72.0	82.5	80.0	80.0	77.0	74.0	70.0
1.5	82.5	80.0	84.0	81.5	85.5	82.5	77.0	74.0
2.0	84.0	81.5	84.0	81.5	86.5	84.0	82.5	80.0
3.0	85.5	82.5	87.5	85.5	87.5	85.5	84.0	81.5
5.0	87.5	85.5	87.5	85.5	87.5	85.5	85.5	82.5
7.5	88.5	86.5	89.5	87.5	89.5	87.5	85.5	82.5
10	89.5	87.5	89.5	87.5	89.5	87.5	88.5	86.5
15	90.2	88.5	91.0	89.5	90.2	88.5	88.5	86.5
20	90.2	88.5	91.0	89.5	90.2	88.5	89.5	87.5
25	91.0	89.5	92.4	91.0	91.7	90.2	89.5	87.5
30	91.0	89.5	92.4	91.0	91.7	90.2	91.0	89.5
40	91.7	90.2	93.0	91.7	93.0	91.7	91.0	89.5
50	92.4	91.0	93.0	91.7	93.0	91.7	91.7	90.2
60	93.0	91.7	93.6	92.4	93.6	92.4	91.7	90.2
75	93.0	91.7	94.1	93.0	93.6	92.4	93.0	91.7
100	93.6	92.4	94.5	93.6	94.1	93.0	93.0	91.7
125	94.5	93.6	94.5	93.6	94.1	93.0	93.6	92.4
150	94.5	93.6	95.0	94.1	95.0	94.1	93.6	92.4
200	95.0	94.1	95.0	94.1	95.0	94.1	94.1	93.0
250	95.4	94.5	95.0	94.1	95.0	94.1	94.5	93.6
300	95.4	94.5	94.5	94.5	95.0	94.1	--	--
350	95.4	94.5	95.4	94.5	95.0	94.1	--	--
400	95.4	94.5	95.4	94.5	--	--	--	--
450	95.4	94.5	95.4	94.5	--	--	--	--
500	95.4	94.5	95.8	95.0	--	--	--	--

Notes:

1. **Values included in the table above were taken from the NEMA Standards MG 1-2006**

Table 12-12
NEMA Premium Full Load Efficiencies[1]
OPEN MOTORS

	3600 RPM		1800 RPM		1200 RPM	
Hp	Nominal Efficiency	Minimum Efficiency	Nominal Efficiency	Minimum Efficiency	Nominal Efficiency	Minimum Efficiency
1.0	77.0	74.0	85.5	82.5	82.5	80.0
1.5	84.0	81.5	86.5	84.0	86.5	84.0
2.0	85.5	82.5	86.5	84.0	87.5	85.5
3.0	85.5	82.5	89.5	87.5	88.5	86.5
5.0	86.5	84.0	89.5	87.5	89.5	85.7
7.5	88.5	86.5	91.0	89.5	90.2	88.5
10	89.5	87.5	91.7	90.2	91.7	90.2
15	90.2	88.5	93.0	91.7	91.7	90.2
20	91.0	89.5	93.0	91.7	92.4	91.0
25	91.7	90.2	93.6	92.4	93.0	91.7
30	91.7	90.2	94.1	93.0	93.6	92.4
40	92.4	91.0	94.1	93.0	94.1	93.0
50	93.0	91.7	94.5	93.6	94.1	93.0
60	93.6	92.4	95.0	94.1	94.5	93.6
75	93.6	92.4	95.0	94.1	94.5	93.6
100	93.6	92.4	95.4	94.5	95.0	94.1
125	94.1	93.0	95.4	94.5	95.0	94.1
150	94.1	93.0	95.8	95.0	95.4	94.5
200	95.0	94.1	95.8	95.0	95.4	94.5
250	95.0	94.1	95.8	95.0	95.4	94.5
300	95.4	94.5	95.8	95.0	95.4	94.5
350	95.4	94.5	95.8	95.0	95.4	94.5
400	95.8	95.0	96.2	95.4	96.2	95.4
450	95.8	95.0	96.2	95.4	96.2	95.4
500	95.8	95.0	96.2	95.4	96.2	95.4

Notes

1. **Values included in the table above were taken from the NEMA Standards MG 1-2006.**

Table 12-12
NEMA Premium Full Load Efficiencies[1]
ENCLOSED MOTORS

	3600 RPM		1800 RPM		1200 RPM	
Hp	Nominal Efficiency	Minimum Efficiency	Nominal Efficiency	Minimum Efficiency	Nominal Efficiency	Minimum Efficiency
1.0	77.0	74.0	85.5	82.5	82.5	80.0
1.5	84.0	81.5	86.5	84.0	87.5	85.5
2.0	85.5	82.5	86.5	84.0	88.5	86.5
3.0	86.5	84.0	89.5	87.5	89.5	87.5
5.0	88.5	86.5	89.5	87.5	89.5	87.5
7.5	89.5	87.5	91.7	90.2	91.0	89.5
10	90.2	88.5	91.7	90.2	91.0	89.5
15	91.0	89.5	92.4	91.0	91.7	90.2
20	91.0	89.5	93.0	91.7	91.7	90.2
25	91.7	90.2	93.6	92.4	93.0	91.7
30	91.7	90.2	93.6	92.4	93.0	91.7
40	92.4	91.0	94.1	93.0	94.1	93.0
50	93.0	91.7	94.5	93.6	94.1	93.0
60	93.6	92.4	95.0	94.1	94.5	93.6
75	93.6	92.4	95.4	94.5	94.5	93.6
100	94.1	93.0	95.4	94.5	95.0	94.1
125	95.0	94.1	95.4	94.5	95.0	94.1
150	95.0	94.1	95.8	95.0	95.8	95.0
200	95.4	94.5	96.2	95.4	95.8	95.0
250	95.8	95.0	96.2	95.4	95.8	95.0
300	95.8	95.0	96.2	95.4	95.8	95.0
350	95.8	95.0	96.2	95.4	95.8	95.0
400	95.8	95.0	96.2	95.4	95.8	95.0
450	95.8	95.0	96.2	95.4	95.8	95.0
500	95.8	95.0	96.2	95.4	95.8	95.0

Notes

1. **Values included in the table above were taken from the NEMA Standards MG 1-2006.**

PART 3 EXECUTION

3.1 GENERAL

A. Install all motors in accordance with the manufacturer's printed recommendations and as required under the specific specification sections for the driven equipment.

3.2 INSTALLATION

A. Motors shall be stored indoors in a clean, dry location with space heaters energized to preclude moisture buildup.

B. Bolt the motor to the equipment or rigid foundation using bolts of the largest size permitted by the holes in the motor bracket. Do not install motors in such a way as to restrict motor ventilation.

C. Motor enclosure type shall be used in the following locations unless otherwise specified in the technical specifications:

1. ODP: Non-hazardous, relatively clean, dry, well ventilated area, indoors.

2. WPI: Indoor/Outdoor, relatively clean area, minimal rain and snow.

3. WPII: Indoor/Outdoor, severe rain and snow, dirty environment.

4. TEFC: Indoor/Outdoor, wet, dirty or dusty environment.

3.3 FIELD QUALITY CONTROL

A. Submit field test procedures for the City’s approval before testing begins. Test and submit test results for each motor.

B. Field tests and inspections: Field testing shall be as specified in Section 16000.

END OF SECTION

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SECTION 16230 – STANDBY DIESEL ENGINE DRIVEN GENERATORS

PART 1 GENERAL

1.1 SCOPE OF WORK

A. Work included:

1. The Contractor shall provide a complete factory assembled generator sets and required supporting systems and materials as specified herein.

2. The engine generator systems will be used to provide standby power to the City of Brentwood Wastewater Treatment Facility.

3. Provide factory test startup services and on-site testing of the systems by a supplier authorized by the equipment manufacturer(s).

4. The Contractor shall provide the coordination and permitting for the new generator.

5. Coordinate size of generator governor with motors operated by variable frequency drives (VFD's).

B. Related:

1. Section 16000 – Common Work Results for Electrical

2. Section 16436 – 480 Volt Switchgear

3. Section 16260 – Low Voltage Adjustable Speed Motor Controllers

1.2 SYSTEM DESCRIPTION

A. The engine generators shall have continuous power ratings of not less than 1000 kW, 80 percent lagging power factor at 480Y/277 volt, 3 phase, 4 wire, 60 Hertz.

B. The engine generators shall be arranged for automatic starting and stopping and load transfer upon failure of the normal source of power as sensed and signaled from the source transfer controller of the switchgear.

C. The engine generator package shall be complete in all respects and shall include all equipment and controls necessary for a fully operational system.

D. The equipment to be furnished under this Section includes, but shall not be limited to the following:

1. Skid mounted diesel engine and generator set.

2. Weatherproof sound attenuated housing.

3. Exhaust system.

4. Double walled skid base fuel tank, including transfer piping, fill system, valves, leak detection system and appurtenances.

5. Engine mounted alternator with skid mounted battery system.

6. Spring vibration isolators for the support of the generator skid frame.

7. Skid mounted engine generator control panel and appurtenances.

8. Skid mounted generator circuit breaker.

9. Skid mounted radiator and cooling fans.

10. Spare parts and special tools.

11. Field services, testing and training.

12. Warranty.

E. Performance requirements:

1. The voltage regulation shall be within plus or minus one percent from no load to full-rated load. Random voltage variation with any steady load from no load to full load shall not exceed plus or minus .5 percent. Upon application or removal of full-rated load in one step, the transient voltage and recovery to steady state operation shall be within three seconds.

2. Frequency regulation shall be isochronous from steady state no load to steady state full load. Random frequency variation shall not exceed plus or minus 0.25 percent (0.15 Hertz).

3. The diesel engine-generator sets shall be capable of load pick up of 100% nameplate kW and power factor, at site conditions, with the engine generator at the temperature as maintained by the engine water jacket heater. Load steps shall be as follows:

   a. Load Step 1 – Plant Base load of:

      1) 200 kVA of motor loads

      2) 150 kVA of lighting and ancillary loads

   b. Load Step 2 – Aeration Blower 1 @ 200 HP; RVSS starter

   c. Load Step 3 – Aeration Blower 2 @ 200 HP; RVSS starter

   d. Load Step 4 – Aeration Blower 3 @ 200 HP; RVSS starter

   e. Load Step 5 – RAS pumps 2 @ 25 HP VFD

4. Motor starting capability shall be as required by the loads indicated on the single line diagram. The engine generators shall be capable of sustaining a minimum of 90% of rated no load voltage with the specified kVA load at near zero power factor applied to the generator set.

5. The engine generators shall be capable of starting the loads with a maximum of 20% starting voltage dip and frequency dip.

6. Emissions shall meet the requirements of Tier 2, U.S. EPA approved for emergency non road use.

7. The engine generator system shall be classed as a Level 2 Emergency Power system as defined by NFPA 110.

8. The alternator shall produce a clean AC voltage waveform, with not more than 5% total harmonic distortion at full linear load, when measured from line to neutral, and with not more than 3% in any single harmonic, and no 3rd order harmonics or their multiples.

9. The generator set shall be certified by the engine manufacturer to be suitable for use at the installed location and rating and shall meet all applicable exhaust emission requirements at the time of commissioning.

10. The generator set, complete with sound attenuated enclosure, shall be tested by the generator set manufacturer per ANSI S1.13. Data documenting performance shall be provided with submittal documentation.

F. Noise Limitations

1. Generators shall be enclosed in a sound attenuated enclosure meeting the requirements of the City of Brentwood noise ordinance or that achieves a dBA of not greater than 75 dBA (nominal) at the property line of the plant whichever is lower. Noise readings shall be made with the unit operating at full load with the noise limitations measured at any point around the unit and/or at the property line.

G. Equipment Anchorage Requirements

1. The Contractor shall design the anchorage for the generator set skid and submit calculations for review by the Engineer. Design shall account for seismic forces as noted in Section 01612.

2. Design shall be based on installation on the equipment concrete pad as included in the Contract Drawings.

3. The Contractor shall provide details of the anchor bolt type, size, and connections to engine-generator skids. The anchor bolts shall be 304 stainless steel and designed specifically for equipment furnished under this Contract. Anchor bolts shall be epoxy adhesive drill-in type.

4. The Contractor will be responsible for providing adhesive anchorage systems and for installing the generator set skid.

1.3 SUBMITTALS

A. All submittals shall be in accordance with Section 01340 and Section 16000.

B. Equipment submittals shall include the following:

1. Shop drawings, catalog cuts, internal wiring schematics and other materials required to completely describe the systems and equipment being furnished.

2. Identification, description and dimensions for each separately installed sub-assembly or piece of equipment and associated piping and electrical connection schematics.

3. Performance specifications of all items of equipment.

4. Generator enclosure panel layout drawings showing location of control panel, instruments and access to generator equipment such as the radiator, batteries, etc. The layout drawings shall also include dimensions and paint finish specifications.

5. Layout drawings of the integral fuel tank, including leak detection equipment, fill point, valves, pressure switches, etc.

6. Submit information on the fuel tank and indicate that the outer shell shall have a volume of 110 percent.

7. Complete electrical, instrumentation, control and wiring diagrams of instrumentation and controls and electrical components. Specifically, the following is required:

    a. Complete electrical circuit schematics, including generator control, alarms and power to all motors, accessories, and instruments furnished with the unit. Schematics shall include all termination points in each control panel. Wiring shall be identified by numbers and every termination point shall be assigned a number. Termination point number (including wire number) shall appear on the schematics for each wiring termination shown. Submit written description of the operational control theory with the schematics.

    b. Complete external electrical interconnection diagrams detailing exact terminals of connection, conduit sizes, and recommended wire sizes.

C. Submit information for the following components:

1. Engine Data

    a. Manufacturer and Model

    b. Engine type

    c. Number and arrangement of cylinders

    d. Rated RPM

    e. Governor type including make and model

    f. Maximum power (kW) at rated RPM and site temperature and altitude conditions

    g. Main bearings, quantity and type

    h. EPA Tier 2 certification.

i. Certification of Emissions for the engines including data on particulate matter, precursor organic compounds (POC), non-precursor organic compounds (NPOC), nitrogen oxides (NOx), and carbon monoxide (CO).

2. Generator Data

   a. Manufacturer and Model

   b. Generator type

   c. Exciter type

   d. Voltage regulator

   e. Rated KVA

   f. Rated KW

   g. Voltage

   h. Insulation rating and temperature rise data

   i. Frequency

3. Generator efficiency, including excitation losses, at 80 percent PF

   a. Full load

   b. Three-quarters load

   c. Half load

4. Guaranteed fuel consumption rate (at 138,000 BTU/gallon)

   a. Full load, gal/hr

   b. Three-quarters load, gal/hr

   c. Half load, gal/hr

5. Generator unit, enclosure and accessories

   a. Weight of skid mounted unit including fuel and tank

   b. Overall length

   c. Overall width

   d. Overall height

   e. Fuel tank details including construction, capacity, leak and fuel level detectors

   f. Exhaust pipe size, silencer manufacturer and silencer attenuation curve

g. Size and locations of conduit stub-up areas.

6. Details of the battery system including calculations for sizing batteries that indicates compliance with battery load and environmental starting requirements listed herein.

7. Network Communications Interface.

   a. Submit network module data sheets and memory mapping for starters and other devices resident within the assembly network. Submit device parameter list with all data variables available for remote monitoring over the network interface. List shall include variable internal name, descriptive field that fully describes the contents and use of the variable, memory address and bit size, variable type (analog, discrete, text), engineering units, and function (e.g., status, alarm, internal diagnostic, etc.). Include complete configuration instructions including addressing, register allocation, data mapping, and options.

   b. Network access requirements including method for accessing equipment variables, software features, and physical hardware interface details.

   c. Submit network communications factory testing procedures including procedures for testing Modbus and Ethernet interface communications. Procedures shall include method for 100% testing of all variables associated with each device. Procedure shall include factory test forms with sign-off sheets indicating proper transmittal and receipt of each variable, properly scaled, and addressed in conformance with the manufacturer's standard documentation. Include verification of each device Modbus and I/P address conforming to City standards.

8. Dimensional drawings, Bill of Materials, color selection chips, and sound attenuation data for the weather proof sound enclosure.

D. Submit anchorage calculations per the seismic criteria included in Section 01612.

E. Operational Certification

1. Submit certification that each unit is guaranteed to be adequate for motor starting as required by this Specification.

2. Submit certification that the generator alternator size has been coordinated with motor loads operated by variable frequency drives (VFD). Refer to Section 16260 and Section 16442 for type of VFD's specified.

3. Certified Factory test reports.

F. Test Reports

1. Furnish copies of the certified shop test and field test records of the complete engine driven generator units.

2. Submit network communications factory testing procedures including procedures for testing Ethernet interface communications. Procedures shall include method for 100% testing of all variables associated with each device. Procedure shall include factory test forms with sign-off sheets indicating proper transmittal and receipt of each variable, properly scaled, and addressed in conformance with the manufacturer's standard documentation. Include verification of each device I/P address conforming to City standards.

G. Air Emission Certification

1. The engine generator systems shall comply with the particulate and combustion gas emission limits of the BAAQMD (Bay Area Air Quality Management District) in effect at time of bid. Coordinate permit requirements with the City. Any pollution mitigation devices or modifications required to permit the specified testing time shall be included in the Contract price.

2. The Contractor shall provide all required backup documentation including risk assessment analyses, details of the engine and its components, etc., to the City that is required by BAAQMD for the air emission installation (Authorization to Construct) and operational permits (Permit to Operate). Final acquisition of the necessary permits shall be by the City using equipment data, calculations, and details provided by the Contractor.

H. Manufacturer's recommendations for long-term storage, including specific types and grades of fluids, lubricants, etc.

1.4 REFERENCES

A. Design, manufacturing and assembly of elements of the equipment herein specified shall be in accordance with but not limited to published standards of the following, as applicable:

1. American Gear Manufacturers Association (AGMA)

2. American Institute of Steel Construction (AISC)

3. American Iron and Steel Institute (AISI)

4. American Society of Mechanical Engineers (ASME)

5. American National Standards Institute (ANSI)

6. American Society for Testing and Materials (ASTM)

7. American Welding Society (AWS)

8. Anti-Friction Bearing Manufacturers Association (AFBMA)

9. Institute of Electrical and Electronics Engineers (IEEE)

10. National Electrical Code (NEC)

11. National Electrical Manufacturers Association (NEMA)

12. Occupational Safety and Health Administration (OSHA)

13. Steel Structures Painting Council (SSPC)

14. Underwriters Laboratories, Inc. (UL)

15. National Fire Protection Association (NFPA)

1.5 QUALITY ASSURANCE

A. The engine generators shall be a standard product, as modified by these Specifications, of a manufacturer regularly engaged in the production of this type of equipment.

B. The engine generator supplier shall be regularly engaged in the design and the installation of engine generator systems and their associated subsystems as they are applied to the municipal water or wastewater industry. The engine generator supplier shall be an organization that complies with all of the following criteria:

1. Maintains a permanent service organization and supply of spare parts in place at the time of the bid within 200 miles of the project site.

2. Supplies service and warrantee work for the engine and generator portion of the unit with their own employees.

3. Employs design, fabrication, testing and field service personnel on this project who have successfully completed a manufacturer's training course on the specific engine generator set proposed for this project.

4. Is an authorized distributor for the specified manufacturer of the engine and generator.

5. Furnishes a unit assembled from components with proven compatibility, reliability and are coordinated to operate as a unit.

6. Owns and operates service trucks dedicated to the purpose of providing field service on the engine generator and associate components.

7. Has performed work of similar or greater complexity on at least five previous projects.

C. The generator set manufacturer shall be certified to ISO 9001 International Quality Standard and shall have third party certification verifying quality assurance in design/development, production, installation, and service, in accordance with ISO 9001.

1.6 MANUFACTURER'S FIELD SERVICES

A. The generator manufacturer shall provide the field services of a factory technician as necessary to supervise/inspect installation, test and start-up all equipment provided as part of the price proposal. The price shall include all travel and living expenses in addition to the technician's time required to complete supervision of the installation, testing and start-up. All equipment required for testing, start-up and performance verification shall be provided by the manufacturer's technician.

B. At a minimum the manufacturer shall provide the following technician person hours for each generator system:

Description	Person Hours
Inspection	**4**
Installation Assist	**12**
Settings, Adjustments	**8**
Start Up and Testing	**8**
Training	**8**

1.7 DELIVERY, STORAGE AND HANDLING

A. After successful factory tests and other required milestones, the generators shall be stored at the Contractor's expense until the installation site is ready to accept shipment. The unit shall be stored at a storage facility acceptable to the City in accordance with all manufacturers' requirements for long-term storage. City shall have access to the units during storage.

B. Ship equipment, material and spare parts to each site complete except where partial disassembly is required by transportation regulations or for protection of components.

C. Pack spare parts in containers bearing labels clearly designating contents and pieces of equipment for which intended.

D. Mechanical and electrical equipment shall be coated, wrapped and otherwise protected from snow, rain, drippings of any sort, dust, dirt, mud, flood and condensed water vapor during shipment and while stored before construction.

E. The Contractor shall pay all costs of delivery to the installation site, and the Contractor will provide equipment and labor for unloading the engine generator at the installation site. Refer to Section 01600 for additional requirements.

1.8 PROJECT/SITE REQUIREMENTS

A. The engine generators and associated equipment shall be suitable for continuous operation at the intended site condition in and around the City of Brentwood. The engine generator systems shall be provided with a weatherproof sound attenuated enclosure and will be installed outdoors.

1.9 MAINTENANCE

A. Spare Parts

1. Provide the following spare parts per unit:

a. Two air filter elements.

b. Two lube oil filter elements

c. Two fuel oil filter elements

d. One set of hoses and belts including one of each different size and type.

e. Three complete replacement sets of fuses of each different size and type.

f. Two complete change of lube oil plus one gallon of make-up lube oil supplied in unopened containers.

g. Six pilot lamps of each type and voltage.

h. One quart of touch-up paint in each color used on the main assembly and housing.

2. The spare parts and maintenance tools shall be packed in containers, permanently labeled by word and part number for easy identification of the items and with the words "For Use Only for the __KW Diesel Engine Generator Unit installed at ____ " (fill in rating and location) and properly packed for an extended period of storage before use.

1.10 OPERATION AND MAINTENANCE MANUAL

A. Complete Operations and Maintenance Manuals, as required in Section 01730. The manual shall be prepared specifically for this installation and shall include all required cuts, drawings, equipment lists, descriptions, as built wiring diagrams, etc. that are required to instruct operation and maintenance personnel unfamiliar with such equipment.

B. Three copies of the Operation and Maintenance Manual shall be submitted for the engine generator system. Operation and Maintenance Manuals shall include successfully completed Factory and Field Test results for the engine generator system. The Operation and Maintenance Manuals shall be favorably reviewed as a requirement for final acceptance of the system. Favorable review status is ‘No Exceptions Noted’ or ‘Make Corrections Noted’.

1.11 SIGNAGE

A. A sign shall be posted at the service entrance equipment indicating type and location of the power source.

B. Provide nameplates per Section 16075

1.12 WARRANTY

A. Provide warranty as specified in 01740.

B. Warranty shall cover all system parts and labor.

C. The generator set supplier shall warrant all equipment provided under this section, so that there is one source for warranty and product service. Technicians trained and certified by the manufacturer to support the product and employed by the generator system supplier shall service the generator sets.

1.13 MANUFACTURE'S

A. Acceptable Engine Generator Manufacture's shall be:

1. Caterpillar

2. Cummins

3. Kohler

4. Or approved equal

PART 2 PRODUCTS

2.1 GENERAL

A. Equipment and controls specified in this Section shall be new and be considered part of the engine generator system; the Contractor shall be responsible for integrating and furnishing the system in its entirety as specified herein.

B. The engine generators and related equipment shall be designed and constructed in conformance with the requirements of UL 2200, Engine Generator Assemblies.

C. Mechanical equipment shall be designed and built for 24 hour continuous service at any and all points within the specified range of operation without overheating or excessive vibration or strain, and require only that degree of maintenance generally accepted as peculiar to the specific type of equipment required. Parts and components of all units shall be designed and built for interchangeability so that replacement parts may be installed without any additional fitting or machining.

D. The engine generator systems shall allow easy access to the various parts for maintenance purposes. All parts shall be properly enclosed to prevent the throwing or dripping of oil.

E. The engine generator systems shall be pre-piped and pre-wired insofar as possible.

F. Provide terminals housed in an enclosure for connection of all remote alarm, control and status signals to and from the generator control panel as shown on the Drawings. Generator 480 VAC power output cables shall be connected directly to the generator output breaker terminals.

G. All conductors shall be installed in rigid or flexible conduit as specified in Section 16120. Provide grounding bushings at conduit entrances to terminal boxes and enclosures on the unit.

H. Supporting Structure: The diesel engine generator shall be directly bolted, doweled, and aligned on a rigid, fabricated steel base, suitably sized to maintain the correct alignment, supported by heavy duty spring type vibration isolators. For stationary units, isolators shall be suitable for anchoring to the level surface of a concrete pad.

2.2 RATING

A. The generator sets shall operate at 1800 rpm and at a voltage of: 277/480 Volts AC, three phase, 4-wire, 60 hertz.

B. The complete generator sets shall be rated per ISO8528 as shown on the Drawings at 0.8 PF, standby rating, based on site conditions of: Altitude 100 feet, ambient temperatures of 40 degrees C, based on temperature measured at the control for indoor installations, and measured at the air inlet closest to the alternator for outdoor equipment.

C. The generator set rating and design shall be based on Legally Required Standby Systems per NEC Article 701.

2.3 EQUIPMENT

A. Engine and Governor

1. The engine generator set shall be a factory assembled unit, specifically designed and equipped for operation on No.2 diesel fuel oil with a radiator and fan cooled. The engine and generator shall be directly connected with a semi-flexible steel coupling, shall be free from injurious torsional or other vibration and shall be vibro-mounted to a heavy steel sub-base.

2. The diesel engine shall be minimum 12 cylinders, four stroke cycle, turbo-charged, and arranged for direct connection to an alternating current generator. The unit shall operate at a rotative speed of not more than 1800 rpm. Units offered at ratings in excess of their published ratings are not acceptable and will not be approved.

3. Governor shall be electronic, powered from the engine starting batteries and capable of maintaining isochronous regulation from no load to full rated load within 0.25 percent of rated frequency. It shall have the capacity for manual adjustment of speed setting and speed droop. Speed droop shall be adjustable from 0 to 5 percent from no load to full load. It shall be designed and installed to eliminate all electromagnetic interference and non sinusoidal waveforms.

4. The control system shall actively control the fuel rate and excitation as appropriate to the state of the generator set. Fuel rate shall be regulated as a function of starting, accelerating to start disconnect speed, accelerating to rated speed, and operating in various isochronous or parallel states.

5. Furnish a separate overspeed shutdown device which shall, in case of predetermined overspeed or the operation of various protective devices as later specified, instantly stop the engine without the fuel injection system losing its prime.

B. GENERATOR AND EXCITATION SYSTEM

1. The generator shall be of the open drip-proof bracket type, especially designed for connection to the engine and shall be for three phase, 60 Hertz, 4 wire, 480Y/277 volt operation. The generator shall have Class H insulation rated for 105 degree C temperature rise. The generator shall have Amortisseur windings.

2. The generator shall have a forged or cast alloy steel flanged shaft for direct connection through a suitable flywheel type coupling to the engine, or with suitable adapter and disc coupling and shall be of the single bearing type with anti-friction bearing.

3. The generator windings shall be braced to withstand short stresses and shall be designed to withstand overheating or stresses caused by harmonics generated by up to 15% non-linear loads. The unit influence shall be "Radio Interference Proof" (RIP) and the "Telephone Influence Factor" (TIF) shall be within the limits of Section 9, ANSI C50.12.

4. The generator shall be brushless with a rotating permanent magnet generator type exciter system, 3 phase solid state voltage regulator with filters and associated controls. Exciter shall have Class H insulation rated for Class F temperature rises.

5. The generator stator core shall be built of low carbon steel laminations, precision-punched, deburred and individually insulated. Stator coils shall be random wound and inserted in insulated core slots. Wound core shall be insulated. Armature lamination followers and frame ribs shall be welded integral with frame. Enclosure shall be drip-proof guarded.

6. Generator rotor poles shall be built up of individually insulated steel punchings. Poles shall be wet layer wound and insulated with VPI/epoxy resin. Cage connections shall be brazed for strong construction and permanent electrical characteristics. Each pole shall be securely bolted to rotor shaft.

7. A directional blower shall be mounted to draw cooling air from exciter end, over rotor poles and through louvered openings in drive end.

8. The generator shall have grease lubricated anti-friction bearings. The designed bearing life, based on B-10 curve of the Anti-Friction Bearing Manufacturers Association, shall be not less than 40,000 hours.

2.4 GENERATOR SYSTEMS

A. Diesel Fuel System

1. Each engine fuel injection system shall include replaceable element type fuel oil filters, integral fuel supply pump, and flexible connectors for both fuel supply and return piping.

2. The diesel fuel system shall include a base-mounted diesel storage tank with leak detection monitor, fuel piping and fittings and isolating ball valves as specified herein.

   a. Tank capacity shall provide for 8-hour operation at full load at a minimum. The tank shall have dual shells (primary and secondary) with continuous welds and an annular space for monitoring leaks. The outer shell shall completely enclose the inner tank and have a volume of 110 percent of the inner tank. The tank piping and fittings shall meet the requirements of Uniform Fire Code 37, 79-7, 110, and UL142.

   b. Tanks with a capacity of 660 gallons or less shall comply with UL subject 2080 Outline of Investigation for Fire Resistant, Insulated Tanks.

c. The tank shall be equipped with the following:

1) Leak detection system with monitoring panel. Leak detector shall monitor the annular space between the walls of the fuel tank and shall include an auxiliary contact for remote alarm at the generator control panel.

2) Tank low level alarm switch; tank low-low level alarm and shutdown switch.

3) Fill assembly with 4-inch fill, cap, minimum 7-gallon UL-listed overfill/spill containment with automatic shutoff valve on overflow. There shall be a manual drain back to the main tank.

4) Vent pipe and appurtenances. Vent package shall meet NFPA 30.

5) Mechanical fuel level gauge.

6) Electronic fuel level transducer and transmitter.

d. The internal tank shall pass a 24 hour factory pressure test at pressure rating recommended by the tank supplier and applicable codes.

e. Fuel piping, fittings, and valve shall be Schedule 40 black steel or stainless steel tubing.

f. Provide isolating valves for the fuel lines at engine. The valve shall be shall be ball type with lever handles, bronze and stainless steel construction suitable for diesel fuel service.

g. Provide pressure relief valve designed to limit fuel line pressure to a maximum of 2.5 psi. Relief valve shall vent outside the enclosure and oriented to avoid potential spraying of personnel with diesel fuel.

h. Provide fuel line check valve or other means to maintain prime in the fuel line and ensure immediate starting capability.

i. The tank shall be labeled "Diesel Fuel Only" and have the NFPA placard. An NFPA placard shall be placed on the enclosure door. H=0, F=2, R=0.

3. The engine driven fuel supply pump shall discharge through a series filtration system, consisting of a 10 micron particle removal cartridge, followed by a water separation cartridge. A pressure relief valve shall be furnished and installed upstream of the filters and arranged to discharge into the fuel tank. The excess fuel supplied to the engine shall be returned to the tank.

B. Electric (Battery) Starting System

1. Starting shall be accomplished by an engine mounted, solenoid shift electric starter, capable of withstanding four consecutive continuous cranking periods of 15 seconds duration each separated by 15 seconds rest periods before shutting down completely and providing an alarm to the control system.

2. The starting batteries shall be low maintenance, long life, lead calcium type, especially designed for diesel engine cranking service and of a capacity as recommended by the battery manufacturer for compliance to NFPA 110 starting requirements. The starting batteries shall be capable of cranking the engine being furnished, for the necessary break-away current as required and the spinning current for four consecutive starts of 15 seconds of cranking on each start, without being recharged, with the system at the site conditions. An insulated protective covering, skid mounted battery rack and suitable cables shall be provided. The rack shall be finished with an acid and fire resistant epoxy coating.

3. Cell containers shall be sealed, shock absorbing, heat resistant plastic with spray proof, flame arresting type vents. Battery shall be furnished with all connectors and hardware, lifting device, cables, and grease.

4. Battery charger shall be a UL 1236 listed device, fully automatic, filtered, float-type, charger suitable for mounting within the Generator enclosure. The chargers shall be designed for heavy-duty industrial service. The DC output shall be regulated to within one percent with plus or minus 10 percent fluctuations of the input voltage and shall be current limited at 120 percent of rated output.

5. Charge rate shall be temperature compensated to provide proper charging in ambient conditions from 20Deg C to plus 55Deg C.

6. The charger unit shall include DC ammeter and voltmeter, adjustable float and equalize controls, AC and DC circuit breakers, AC power failure alarm relay and low DC voltage alarm relay output contacts. Provide fault condition outputs per NFPA 110. Include LED indication of charger status, fault and equalize. LCD display shall include charge rate, battery voltage, configuration menu and commands.

7. Input voltage shall be a separate 120V AC power source as shown on the Drawings.

C. AC Alternator

1. The AC alternator shall be; synchronous, four pole, 2/3 pitch, brushless, revolving field, drip-proof construction, single pre-lubricated sealed bearing, air cooled by a direct drive centrifugal blower fan, and directly connected to the engine with flexible drive disc. The alternator design shall prevent shaft current from flowing and eliminate the need for insulated bearings. All insulation system components shall meet NEMA MG1 requirements for Class H insulation systems. Actual temperature rise measured by resistance method at full load shall not exceed 105Deg C in a 40Deg C ambient.

2. The alternator shall be capable of delivering rated output (kVA) at rated frequency and power factor, at any voltage up to 5 percent above or below rated voltage.

3. The alternator shall be supplied with a dedicated, independent power source for the voltage regulation system, which provides sufficient excitation for the alternator to supply 300 percent of rated output current for 10 seconds.

4. The subtransient reactance of the alternator shall not exceed 12 percent, based on the standby rating of the generator set.

5. Provide an anti-condensation heater for the alternator for generator sets installed outdoors or in unheated environments.

D. Air Intake System

1. The engine shall be equipped with suitably sized dry type air intake filter(s) to protect working parts of the engine from dirt and grit with replaceable type filter element. A crankcase breather shall be included.

E. Lubrication System

1. The engine shall be provided with a full pressure lubricating oil system arranged to cool the pistons and to distribute oil to all moving parts of the engine including the turbocharger bearings and including full flow filter of the replaceable element type and a suitably sized shell and tube type oil cooler and an automatic temperature regulator if required. An engine driven lubricating oil circulating pump shall be provided for the engine. This pump shall be of the positive displacement type, and shall have ample capacity to circulate the amount of lubricating oil and cooling oil required by the engine and turbocharger. The engine shall be provided with a sump type crankcase arrangement of sufficient capacity to suit the requirements of the engine.

F. Engine Cooling System

1. Skid-mounted radiator and cooling system rated for full load operation in 50 degrees C ambient as measured at the generator air inlet, based on 0.5 in H_2O external static head. Radiator shall be sized based on a core temperature which is 10C higher than the rated operation temperature, or prototype tested to verify cooling performance of the engine/radiator/fan operation in a controlled environment. Radiator shall be provided with a duct adapter flange. The cooling system shall be filled with a 50/50-ethylene glycol/water mixture by the equipment manufacturer. Rotating parts shall be guarded against accidental contact.

G. Exhaust System

1. Exhaust silencer shall be of the critical grade type. The exhaust pipe shall be ASTM A106 with wall thickness of 0.250-in, black steel with flanged fittings and of the size recommended by the engine manufacturer. Suitable expansion joints shall be provided and installed where required to provide for expansion of the pipe caused by a 1000 degree F temperature change. The exhaust line shall be connected to the engine by a suitable section of flexible stainless steel metal exhaust corrugated tubing suitable for the maximum temperature condition which may be encountered. Exhaust line elbows shall be long radius.

2. Furnish and install suitable silencer equipment for the engine exhaust to attenuate the sound as specified herein.

3. The exhaust silencer shall be factory mounted to the top or inside of the enclosure. The exhaust pipe shall terminate in a device to prevent the entrance of rain.

4. A suitable drain with valve shall be installed at the low point of the exhaust line.

H. Generator Output Circuit Breaker

1. The breaker shall be manually operated 3 pole, molded case circuit breaker, with solid state trip device. The frame and trip rating shall be as shown on the electrical single line drawings.

2. The circuit breaker shall have the following adjustments as a minimum: long time, short time and instantaneous (amps pickup and time delay) and ground fault (amps pickup and time delay).

3. The Contractor shall recommend the setpoints of the breakers based on the characteristics of the equipment furnished. Breaker interrupting ratings shall be suitable for the generator furnished, however shall be 25,000 AIC minimum.

4. The circuit breaker shall be UL listed to be applied at 100% of its rating.

5. The circuit breaker shall be housed in the NEMA rated enclosure mounted on the generator skid.

I. Weatherproof Acoustic Enclosure for Engine Generator Set

1. A weatherproof enclosure for the engine generator set and appurtenances shall be provided and shall be complete with locking access doors, fixed type louvers and screens, exhaust ventilators and screens, and other appurtenances as required for complete installation.

2. The enclosure shall be factory mounted to the engine generator skid base by the engine generator supplier and shipped to the site as an integral component of the generator system.

3. The enclosure shall be an all welded, formed sheet metal type, custom fabricated from ASTM A36 galvanized sheet steel. Wall and roof skin thickness shall be a minimum of 14 gauge panels be welded along 1 inch support flanges for added strength.

4. The access panels shall be constructed of 14 gauge galvanized sheet steel with same thickness as the wall panels and shall include hinged doors or a lift off feature to access all adjustable or maintainable components. The access panel hardware shall be zinc plated, and use a keyed alike 2-point locking system. The number and location of the access panels shall be provided as required to allow servicing of the engine generator unit.

5. Roof exhaust pipe opening and collar with rain cover shall be provided as required by the engine.

6. All electrical components internal to the enclosure shall be arranged to ensure conformance with NEC required minimum working space.

7. The enclosure shall be factory wired insofar as possible. Provide terminal boxes connection of all alarm, control and power conductors to the enclosure. Separate boxes shall be provided for 480 VAC, 120 VAC, and DC wiring as applicable. All conductors within the enclosure shall be installed in rigid or flexible conduit as specified in Section 16130. Provide grounding bushings at conduit entrances to terminal boxes and other panels on the unit.

8. The enclosure coating preparation, prime, and finish shall be manufacturer's standard suitable for an aggressive marine environment. The color shall be as selected by the City.

9. Provide within the housing a 20 amp, 120 volt GFCI receptacle for maintenance purposes and a fluorescent light with manual light switch.

10. Provide access stairs at the generator access thresholds for maintenance access to the equipment. Stairs shall be set at the generator enclosure entrance level, above the height of the fuel tank and mounting skid. Provide individual stairs sets at each main entrance points on both side of the enclosure. Access stairs shall conform to the applicable requirements of CAL-OSHA.

J. Jacket Water Heaters

1. Automatic thermostatically controlled heater(s), rated 120 or 240 volt, single phase, shall be provided to maintain not less than 90 degrees F temperature with an ambient temperature of 25 degrees F for the engine jacket water.

2. Heaters shall be automatically deactivated when the engine generator unit is in operation.

3. A separate 120 or 240V power source shall be provided to the jacket heaters as shown on the Drawings.

2.5 GENERATOR CONTROLS

A. General

1. The engine generator shall include an integrally mounted engine generator control system. The components of this section shall be shop mounted inside of the weatherproof enclosure. If required by space or clearance constraints, components may be provided with individual NEMA 4X rated enclosures and shop mounted on the exterior of the overall generator enclosure or remotely where shown on the drawings. The controls shall include, but not be limited to, the following:

   a. Generator voltage regulator control potentiometer (the regulator may be located within the generator enclosure at the manufacturer's option).

   b. 480-120/240 volt control power transformer (CPT) with 480 volt primary circuit breaker for the generator control panel and controls.

   c. Battery charger.

   d. Alarm and status annunciator system.

   e. Engine start and stop controls.

2. The control system including the enclosure, covers, barriers, and supports shall be listed and labeled under the requirements of UL 508A.

3. The generator set shall be provided with a microprocessor-based control system designed to provide automatic starting, monitoring, and control functions for the generator set. The control system shall be designed to allow local monitoring and control of the generator set. The control system shall also allow remote monitoring and control as described herein.

4. Indicators, pilot devices, alarms and controls shall be housed in a control panel mounted within the generator enclosure. The control panel shall have nameplates adjacent to each device to identify the device's function. A wiring diagram shall be pasted to the inside of the door.

5. Control system equipment shall be factory mounted and wired on or within the engine generator enclosure. Wiring shall be numbered in accordance with the numbering system used on the wiring/connection diagrams.

6. Panel wiring shall be stranded copper conductor, 600 volt, insulation type SIS, or approved equal. Minimum size shall be No. 14 AWG for A.C. power wiring and No. 16 AWG for D.C. control wiring.

7. Control relays and timers shall be heavy duty plug-in socket type with a transparent cover. The relays shall have 10 ampere minimum and 120/230VAC contacts. The mechanical life of the relay shall be 10,000 operations minimum.

B. Control Functions and Components

1. Generator output frequency meter, ammeter and voltmeter. The voltmeter and ammeter shall display all three phases. Output display shall be digital in either LED bar graph or LCD.

2. Running time meter and start counter.

3. Engine generator mode selector switch: The controls shall include a three-position RUN-OFF-AUTO switch. In RUN, the engine shall start and run without load transfer; in OFF, the engine shall stop and will not start; in AUTO, the engine shall start and run and stop from the remote engine start contact provided by hardwired contact from the remote switchgear source transfer system.

4. Reset push-button with indicator. Indicator shall flash to indicate that generator set is locked out due to a fault condition.

5. Lamp test push-button. Operation of this push-button shall cause all lamps on the panel to be simultaneously tested. As an alternative, provide push-to-test type pilot lights or digital indicators.

6. Emergency Stop push-button. The emergency stop push-button shall be a red, mushroom head push-button which maintains its position until manually reset.

7. Precision voltage and frequency adjust raise/lower switches or potentiometers. Switches (or potentiometers) shall allow the generator set frequency and voltage to be adjusted plus or minus 5%. Voltage and frequency adjustment switches shall be located inside of the control panel or shall be sealed in a manner to prevent unauthorized adjustment.

8. Provide local operator interface panel with Alpha-numeric display with pushbutton access for viewing engine and alternator data and providing setup controls and adjustments.

9. Alarm and Status Display Panel

   a. Provide and install an alarm and status digital graphic panel with horn, located to allow convenient access and monitoring by facility personnel and per NEC minimum workspace clearances. The display shall be full color with high-visibility LCD type or similar. Panel configuration software shall be provided with the generator to allow future addition of other alarm and status functions to the display by the City. Software shall be licensed to the City to allow display modifications without requiring manufacturer technicians, special tools, or additional software.

   b. Displays shall be configured to include identification and functional labeling of the alarm and status points in a fashion consistent with the specified functions.

   c. Hardware based alarm silence and acknowledge switches shall be provided. Alarm horn shall be switchable for all alarm points. Alarm horn, when switched on, shall sound for first fault, and all subsequent faults, regardless of whether the initial fault has been cleared.

   d. The audible alarm horn shall be a fixed volume (nominally 78-102 db) constant duty type. The alarm horn shall be provided with a panel mounted manual silence pushbutton. The alarm horn circuit shall also be provided with a timer to automatically silence the horn during unattended operation (adjustable from 0-60 seconds). The automatic timer silencing circuit shall have an on – off switch to allow it to be either utilized (in automatic silence mode) or disabled (requiring manual reset of the horn.)

   e. The following alarm, shutdown, and status conditions are required for presentation on the generator graphic screen, at a minimum:

Function	Alarm	Shutdown	Status
Low DC Voltage	*	-	-
High DC Voltage	*	-	-
Battery Charger AC Malfunction	*	-	-
Low Oil Pressure	*	*	-
High Oil Temperature	*	*	-
Fuel Tank – Low Level	*	-	-
Fuel Tank – Leak	*	-	-
Not in Auto	*	-	-
Low Water Jacket Temp	*	-	-
High Water Jacket Temp	*	*	-
Low Coolant Level	*	-	-
High Coolant Temp	*	*	-
Overcrank		*	-
Fail to Crank	-	*	-

Function	Alarm	Shutdown	Status
Overspeed		*	
Under Frequency	*	*	-
Under Voltage	*	*	-
Over Voltage	*	*	-
Emergency Stop In Automatic	*	*	*
Generator Running	-	-	*

10. Engine performance status monitoring shall be incorporated on the digital display panel and include the following at a minimum. Displays shall show the analog value in the indicated engineering units and include means for establishing alarm setpoints for the variables.

    a. Engine oil pressure (psi

    b. Engine coolant temperature (degrees F or C)

    c. Engine oil temperature (degrees F or C)

    d. Engine speed (rpm)

    e. Number of hours of operation (hours)

    f. Number of start attempts

    g. Battery voltage (DC volts)

11. Engine Control Functions

    a. The control system provided shall include a cycle cranking system, which allows for user selected crank time, rest time, and # of cycles. Initial settings shall be for 3 cranking periods of 15 seconds each, with 15-second rest period between cranking periods.

    b. The control system shall include an engine governor control, which functions to provide steady state frequency regulation as noted elsewhere in this specification. The governor control shall include adjustments for gain, damping, and a ramping function to control engine speed and limit exhaust smoke while the unit is starting. The governor control shall be suitable for use in paralleling applications without component changes.

    c. The control system shall include time delay start (adjustable 0-300 seconds) and time delay stop (adjustable 0-600 seconds) functions.

12. Engine warning conditions shall be grouped to provide a common alarm. All shutdown alarms shall be grouped to provide a common alarm. Provide a status indication for generator run status. These items shall be available for remote monitoring via the network communications.

13. Complete engine start control which operates on closing contact and stop control which operates on hardwired contact from the remote switchgear automatic source transfer control system.

14. Cranking limiter to disconnect the starting motor from the battery supply after completing a total of four 15 second cranking periods separated by 15 second rest periods before shutting down completely and alarming.

15. Adjustments shall be broad range, and made via digital raise-lower switches, potentiometers or with a laptop, with an alpha-numeric LED readout to indicate setting level. If software is required to make adjustments, the contractor shall furnish a copy of all required software, cables, and accessories, licensed to the City of Brentwood.

16. AC over/under voltage monitoring system which responds only to true RMS voltage conditions. The system shall initiate alarm and shutdown of the generator set when alternator output voltage exceeds 110% of the operator-set voltage level for more than 10 seconds, or with no intentional delay when voltage exceeds 130%. Under voltage shutdown and alarm shall occur when the output voltage of the alternator is less than 85% for more than 10 seconds.

17. Battery monitoring system which initiates alarms when the DC control and starting voltage is less than 25VDC or more than 32 VDC. During engine starting, the low voltage limit shall be disabled.

18. Controls shall be provided to monitor the output current of the generator set and initiate an alarm (over current warning) when load current exceeds 110% of the rated current of the generator set on any phase for more than 60 seconds. The controls shall shut down and lock out the generator set when output current level approaches the thermal damage point of the alternator (over current shutdown). The protective functions provided shall be in compliance to the requirements of NFPA70 article 445.

19. Controls shall be provided to individually monitor all three phases of the output current for 1, 2, or 3-phase short circuit conditions. The control/protection system shall monitor the current level and voltage. The controls shall shut down and lock out the generator set when output current level approaches the thermal damage point of the alternator (short circuit shutdown).

20. Controls shall be provided to monitor the kW load on the generator set, and initiate an alarm condition (over load) when total load on the generator set exceeds the generator set rating for in excess of 5 seconds. Controls shall include a load shed control, to operate a set of dry contacts (for use in shedding customer load devices) when the generator set is overloaded.

21. The control system shall include a ground fault monitoring relay. The relay shall be adjustable from 3.8-1200 amps, and include adjustable time delay of 0-10.0 seconds. The relay shall be for indication only, and not trip or shut down the generator set. Note bonding and grounding requirements for the generator set, and provide relay that will function correctly in system as installed

C. DC Control Power

1. Control power for the system shall be derived from the generator set starting batteries.

D. Remote Status Signals

1. Provide dry contact status monitoring points including at a minimum Generator Ready to Load, Generator Run, Generator Fail, Low Fuel, and Composite Generator Alarm for remote monitoring by the plant SCADA system. Provide Form "C" dry contacts rated 2A @ 30VDC. Generator set Ready to Load shall operate when voltage and frequency are greater than 90% of rated condition.

2. Provide 4-20mA fuel level monitoring signal for remote monitoring by the plant SCADA system.

3. A fused 10 amp switched 24VDC power supply circuit shall be provided for customer use. DC power shall be available from this circuit whenever the generator set is running.

4. A fused 20 amp 24VDC power supply circuit shall be provided for customer use. DC power shall be available from this circuit at all times from the engine starting/control batteries.

2.6 NETWORK INTERFACE

A. Provide generator network communication module to allow real time communication with the generator set controls with the plant SCADA system over a Modbus TCP network connection as shown on the Drawings. The network link shall communicate all engine and alternator data; alarm, shutdown and status conditions; and allow starting and stopping of the generator set via the network in both test and emergency modes.

B. Provide industry-standard ultra-wide IEEE 802.3u 100Base-TX and 100Base-FX autosensing Ethernet switches supporting Fast Ethernet communications over both fiber optic (FO) and copper cables.

1. Provide managed Ethernet switches with a minimum of sixteen 100Base-TX ports and two 100Base-FX ports. FO ports shall be multi-mode type with type LC connectors.

2. Switch shall be standard 19-inch rack mount type for industrial application having a minimum operating temperature of 60 degree C, and listed for installation in a UL508 control panel.

3. Provide network switch powered from the panel 48VDC power supply

4. Provide conformal coated circuit boards.

5. Switches shall include an alarm relay contact output rated for 1 amp at 24VDC.

6. Managed switches shall be Moxa, N-Tron, or approved equal.

C. Coordinate equipment IP addresses with City Ethernet addressing requirements to be provided to the Contractor upon request.Panel Mounted (Industrial Grade) Ethernet Switches

2.7 SURFACE PREPARATION AND SHOP PAINTING

A. Each engine generator and associated equipment shall be shop cleaned, primed, and finished coated per the manufacturer's standard practice for aggressive marine environments prior to shipment.

PART 3 EXECUTION

3.1 GENERATOR FACTORY TESTS

A. The generator set manufacturer shall perform a complete operational test on the generator set prior to shipping from the factory. All testing shall be performed with calibrated metering. Provide two weeks advance notice of scheduled test dates.

B. Generator set factory tests on the equipment shall be performed at rated load and rated power factor. Generator sets that have not been factory tested at rated power factor will not be acceptable. Tests shall include at a minimum:

1. Run at full load over a minimum 4-hour period; monitor and record phase voltages, currents, power output (kW and kVAR), water temperature, and other variables monitored by manufacturer’s standard factory test procedures.

2. Maximum power

3. Voltage regulation

4. Transient and steady-state governing

5. Single step load pickup

6. Function of safety shutdowns

C. A certified test report shall be provided with the generator set.

3.2 GENERATOR SYSTEM SHOP TESTS

A. Before shipment to the project site, the complete engine generator system, including generator control panel, weatherproof enclosure, silencers, shall be shop tested. Tests shall be performed at the supplier’s service shop. Provide advanced notification to allow, at City’s option, to witness the test. The City shall be notified at least two weeks prior to the proposed testing dates.

B. The supplier shall have successfully performed their own quality assurance adjustments, tests and checks prior to requesting the witnessed shop tests. The purpose of the witnessed shop test shall be to demonstrate unit performance and conformance with all Contract requirements and shall not be utilized to perform routine adjustments or modifications to the unit.

C. Shop tests for the system shall be sufficient to demonstrate that the system will operate successfully and meet all specified operational requirements.

D. The supplier shall furnish all necessary instruments, filters, starting air, fuel, cooling water, electric power and load banks for the test.

E. During shop testing, all automatic safety and shutdown devices shall be tested and their respective activation points shall be recorded.

F. Voltage and frequency regulation and transient response shall be tested and recorded to show full compliance with this Section. Display graphs of the response upon application of the generator rated load in a single step shall be submitted with the test documentation. The graphs shall be annotated to indicate the calibration of each axis. The transient response shall be demonstrated and recorded a minimum of three (3) times. The initial transient test shall be performed with a cold engine. The final transient test shall be performed on the engine at the completion of the four hour load test.

G. The Shop Test shall consist of, but not be limited to, four continuous hours of operation. During the Shop Test, readings shall be taken and recorded every thirty minutes for each of the following parameters at a minimum:

1. Time

2. Ambient temperature

3. Under no load conditions: Volts for each phase

4. Under loaded conditions:

a. Amps for each phase

b. Voltage for each phase

c. KW

d. Power factor

e. Frequency

f. Engine jacket water temperature

g. Cooling water temperature (in and out)

h. Lubricating oil pressure

i. Lube oil temperature

j. Exhaust gas temperature

k. Gallons of fuel consumed per hour

H. Shop test shall include sound tests confirming the specified attenuation requirements at all points around the generator set while operating.

I. Proper operation of the network communications following the favorably reviewed factory testing procedures for testing the network interface communications.

J. After completion of the Shop Test, the supplier shall perform the following:

1. The load limit shall be sealed. The seal shall be applied, using a seal press which embosses the manufacturer's initials on the lead seal.

2. All entrapped water shall be drained, and protection applied to prevent the entry of water during shipment or a long period in storage while waiting for installation.

3. The engine generator shall be given proper treatment for its protection for extended storage while waiting for the installation contract.

K. Certified test records for the generator system shall be submitted to the City for review. Systems shall not be shipped to the installation sites unless results have been given 'No Exceptions Noted' or 'Make Corrections Noted' status. The testing shall be repeated and certified results resubmitted for review at no extra cost to the City as often as necessary for the test results to be considered 'No Exceptions Noted' or 'Make Corrections Noted' by the City.

L. Beginning at the time when the Shop Tests have been completed and favorably reviewed, the supplier shall make the engine generator systems available for delivery to the Contractor.

3.3 INSTALLATION

A. Equipment shall be installed by the Contractor in accordance with final submittals and contract documents. Installation shall comply with applicable state and local codes as required by the authority having jurisdiction. Install equipment in accordance with manufacturer's instructions and instructions included in the listing or labeling of UL listed products.

B. Installation of equipment shall include furnishing and installing all interconnecting wiring between all major equipment provided for the on-site power system. The Contractor shall also perform interconnecting wiring between equipment sections (when required), under the supervision of the equipment supplier.

C. Equipment shall be installed on concrete housekeeping pads. Equipment shall be anchored to the pad in accordance with manufacturer's instructions and seismic requirements of the site.

D. Equipment shall be initially started and operated by representatives of the manufacturer. All protective settings shall be adjusted as instructed by the consulting engineer.

E. All equipment shall be physically inspected for damage. Scratches and other installation damage shall be repaired prior to final system testing. Equipment shall be thoroughly cleaned to remove all dirt and construction debris prior to initial operation and final testing of the system.

F. On completion of the installation by the electrical contractor, the generator set supplier shall conduct a site evaluation and certify that the equipment is installed per manufacturer's recommended practice.

3.4 FIELD START-UP AND TESTS

A. Field start-up and testing shall be provided for the engine generator system by the supplier. Field start-up and testing will be a joint effort with the Contractor as necessary to assure that the system functions as specified. All tests shall be performed in the presence of the City. After the supplier's field service technician's check of the installed system, the engine generator system shall be tested to demonstrate its ability to operate continuously without vibration, jamming, leakage or overheating and to perform specified functions. During start-up and operation, the Contractor will comply with the manufacturer's operating and maintenance instructions.

B. The Field Test shall consist of two separate steps, the engine generator Load Test and the Power System Test. The Load Test shall demonstrate the capability of the installed engine generator and related systems to produce rated power and operate in accordance with manufacturer's recommendations. The Power System Test shall demonstrate the capability of the installed engine generator system to function as a part of the power system.

C. Proper operation of the network communications following the same, favorably reviewed factory testing procedures used for testing the network interface communications. Include delivery of operational data to the plant control system as specified in Section 13400.

D. Field Load Test:

1. Test duration shall be for two continuous hours at the full rated load of the engine generator unit.

2. If required the supplier shall supply a portable resistive load bank for this test.

3. During the test, all parameters recorded during the Shop Test shall be taken and recorded at 30 minute intervals.

4. During the test, all of the automatic shutdown devices shall be retested and the actuation values shall be recorded. Field adjustments shall be made as required to make the operating values correspond to those recommended by the engine generator manufacturer and as recorded during the Shop Test.

E. Power System Test:

1. After the field Load Test has been completed, additional testing shall be performed by the supplier to demonstrate the power supply system's ability to meet the motor starting requirements. Field testing to demonstrate generator automatic start, load "stepping" and load transfer will be performed by the Contractor at the same time.

2. The engine generator system shall be tested by the supplier to demonstrate the automatic startup, transient response, load carrying, cool down and shutdown modes of operation.

F. Provide a pressure test port with threaded plug in the double wall piping termination fitting of each double wall fuel oil line or tank. Containment structures and piping shall be subjected to an air test of 10 psig with a zero allowable leakage rate.

G. If the power supply system fails to fulfill the performance requirements of this specification, corrective action shall be taken and the system retested to assure full compliance. Expenses associated with the field tests, including any corrective action, shall be at no additional cost to the City.

H. The Contractor will be responsible for all fuel and other fluids required by the diesel driven generator for the field tests and will refill the tank on completion of testing.

3.5 TRAINING

A. Training for the engine generator system shall be complete as a condition for Substantial Completion.

B. Training shall include at a minimum, 8 hours of instruction. The training shall include how to operate the generator set and all equipment related to the generator including the switchover equipment. Maintenance instructions shall be included in the training session. Location for the training shall be coordinated with the City.

END OF SECTION

SECTION 16240 – STATION BATTERY SYSTEM

PART 1 GENERAL

1.1 SCOPE OF WORK

A. Batteries, and battery charger for 48VDC station power to substation equipment, switchgear, and other DC loads specified on the Drawings.

B. Unless otherwise specified, design, fabricate, assemble, and test equipment so that upon installation and operation in accordance with the manufacturer's recommended procedures, the equipment will conform to the most current revision of the codes and standards.

C. Coordination of location of batteries in switchgear substation enclosure as shown on the Drawings and as specified in Section 16350.

1.2 RELATED SECTIONS

A. Section 01612 – Seismic Requirements.

B. Section 16000 – Common Work Results for Electrical

C. Section 16080 – Electrical System Analyses and Commission Field Testing

D. Section 16350 – Medium Voltage Switchgear

E. Section 16442 – Panelboards

1.3 SUBMITTALS

A. Provide submittals for approval in conformance with Sections 01340 and 16001:

1. Product data.

2. Bill of materials.

3. Plan, elevation, and section drawings including overall weights and dimensions. Submit layout drawings indicating the method for battery installation within the medium voltage switchgear lineup specified in Section 16350.

4. Plan, elevation, and section drawings including overall weights and dimensions. Submit layout drawings indicating the method for battery installation in the engine room adjacent to the new ECP panels as specified in Section 16491.

5. Internal schematics (elementary diagrams), wiring diagrams, and point-to-point system interconnection diagrams for all equipment. All DC distribution load circuit connections shall be clearly identified.

6. DC panelboard schedule.

7. Battery sizing calculations in accordance with this Section based on the Switchgear DC load requirements for the equipment specified in Section 16350.

8. Equipment seismic qualifications, seismic calculations, and anchorage details as specified in Section 01612.

9. Evidence that battery systems comply with current PG&E battery systems for primary metering and disconnecting installations.

10. Evidence that battery systems comply with the requirements of the California Fire Code, Article 608.

11. Warranty

B. Provide additional submittals for approval in conformance with Section 01750 and 16000:

1. Instruction manuals.

2. As-built documents and Operation and Maintenance (O&M) manuals.

3. Certified factory test reports.

4. Field acceptance testing reports.

C. Submit battery and charger for utility review as required by PG&E interconnection requirements. Submittals to the utility shall only be made following favorable review of the equipment submittals by the Engineer.

1.4 REFERENCES

A. American National Standards Institute (ANSI)/ Institute of Electrical and Electronics Engineers (IEEE)

1. ANSI/IEEE Std 1106 – IEEE Recommended Practice for Maintenance, Testing, and Replacement of Nickel-Cadmium Storage Batteries for Generating Stations and Substations

B. California Code of Regulations, Title 24, Part 9 – California Fire Code

C. Institute of Electrical and Electronics Engineers (IEEE)

1. IEEE Std 1115 – IEEE Recommended Practice for Sizing Nickel-Cadmium Batteries for Stationary Applications

2. IEEE Std 1491 – IEEE Guide for Selection and Use of Battery Monitoring Equipment in Stationary Applications

D. Pacific Gas & Electric Requirements

1. Utility Bulletin: TD-2999-030, Technical Requirements for Electric Service Interconnection at Primary Distribution Voltages

2. Transmission Interconnection Handbook, Appendix T

1.5 QUALITY ASSURANCE

A. The Contractor shall be responsible for providing all DC load information required to size the batteries for all equipment specified under Section 16350 powered from the battery systems.

B. Only the load information for the exact product supplied by the Contractor shall be used for battery sizing – “typical” data shall not be assumed.

C. Battery technology, make, and model shall comply with and listed by current PG&E requirements for switchgear battery systems for primary metering and disconnect installations.

1.6 MANUFACTURER’S FIELD SERVICES

A. System checkout and startup: Provide the services of a manufacturer’s qualified representative to supervise inspect installation, test, and start-up of the battery system for the medium voltage switchgear as specified in Section 16350. Verify all battery and charger devices are working properly and correctly terminated and powering the switchgear devices. Verify alarm signals for battery and charger. The work shall include all travel and living expenses in addition to the technician’s time required to complete supervision of the installation, testing, start-up, and training as specified herein. All equipment required for testing, start-up, performance verification, and training shall be provided by the manufacturer’s technician.

B. At a minimum the manufacturer shall provide the following technician person-days for each occurrence. However, the Contractor shall provide all necessary manufacturer’s field support for a complete installation, fully tested, and operational as required for a fully functioning system. The minimum durations listed below do not preclude additional time that may be required to achieve all the requirements of the Contract Documents.

Description	Person-Days
Inspection	½
Installation Assist	1
Settings, Adjustments	½
Start Up and Testing	½
Training	½

C. Training

1. Provide training in conformance with Sections 01660 and 16000.

2. Training shall be by the manufacturer’s qualified representative and shall include instruction on complete service, operation, and maintenance of the battery system as recommended by the manufacturer.

1.7 JOB CONDITIONS

A. Seismic load criteria: All supports and anchorage shall be designed in accordance with the seismic criteria of Section 01612.

1.8 SHIPPING AND STORAGE

A. Batteries shall be delivered and installed within 90 days of the battery manufacturer's Date Code. Batteries delivered to the site and not energized within 90 days of the manufacturer's Date Code shall be replaced with new at no additional cost to the Owner.

PART 2 PRODUCTS

2.1 BATTERIES

A. Specifications

1. Type: rechargeable nickel-cadmium.

2. Construction: Flooded pocket plate type, consisting of welded nickel plated steel and non-woven fiber plate construction.

3. Cell container: translucent polypropylene, with welded leak-proof seal.

4. Water maintenance period at float charge at 68 degrees Fahrenheit: minimum twenty (20) years service without topping-up or other maintenance.

5. Oxygen/hydrogen recombination efficiency: minimum 95%.

6. Recharge time to 95% available capacity: maximum 8 hours at normal boost charge.

7. Provide battery installation with battery hold down clamps, terminal covers, lugs, connecting cables, all other accessories as required for a complete installation.

B. Design criteria for the stationary battery system.

1. General: Design criteria for batter sizing is based on the requirements of the switchgear and relaying specified in Section 16350

2. Environmental

a. Nominal Temperature: 68 degrees Fahrenheit.

b. Minimum Temperature: 40 degrees Fahrenheit.

c. Maximum Temperature: 110 degrees Fahrenheit.

3. Charging method: dual-rate.

4. Design margin: 1.1.

5. Aging factor: 1.25

6. Voltage

a. Nominal: 48 VDC.

b. Window: 38 - 56 VDC.

7. Load Profile:

   a. Station control power for the following equipment: Medium-voltage MPS switchgear, protective relays, communication equipment, and system HMI control equipment.

   b. Station batteries shall be sized based on the battery having carried its maximum steady-state load for eight (8) hours and then subject to:

      1) Maximum load involving the one-minute rate consisting of two complete open/close cycles for the main circuit breaker per Section 16350.
      2) As required by PG&E engineering review based on IEEE Standard 1115.
      3) Whichever is greater.

8. Based on the design criteria enumerated above, the expected minimum battery size at a 5 hour discharge rate to 1.0V per cell is:

   a. Number of cells: 4 x 28

   b. Rated capacity: 53 Ah rated capacity.

9. Approximate minimum battery size above is based on assumed requirements for main breaker and relaying equipment. Final battery size is dependent on the final control requirements, breaker trip coil ratings, device ratings, relaying, and proposed battery characteristics. Contractor shall be responsible for determining the final size of the required battery installation based on the implemented system. Provide required batteries specified at no additional cost to the District.

C. Acceptable manufacturers

1. SAFT

2. Alcad Vantage VN series

3. Storage Battery Systems, Inc

4. Approved equal

2.2 BATTERY DISCONNECT SWITCH

A. Provide battery system disconnect switch to isolate batteries for maintenance and testing purposes. Disconnect switch shall be located adjacent to battery rack.

B. Provide heavy duty, 600VDC rated switch with ampere rating as required for the final battery system provided by the Contractor.

C. Provide NEMA 12 enclosure.

D. Acceptable manufacturers

1. Eaton Corporation, Heavy-Duty, Type TH

2. ABB/General Electric, Heavy-Duty, Type DH

3. Or equal

2.3 BATTERY STAND

A. Battery stands shall be seismically designed per the design criteria outlined in this section. Battery stands shall be corrosion resistant.

B. Acceptable manufacturers

1. Alcad

2. Approved equal

2.4 BATTERY CHARGER

A. Battery charger shall be designed for heavy-duty industrial service and capable of full-rated output at temperatures between –20 degrees C and +50 degrees C. Charger shall be capable of recharging fully discharged maintenance-free nickel-cadmium batteries.

B. Charger housing shall be heavy gauge clear anodized aluminum or other rust resistant materials. Charger shall be suitable for back panel mounting.

C. Charger shall be designed and built in accordance with applicable NEMA and UL standards.

D. Charger nominal input voltage: 240 volt, 60 hertz. Input protection shall consist of a circuit breaker and surge suppression devices.

E. Charger output voltage shall be 48VDC nominal with provision for customer connection of either polarity or ground. Float voltage shall be adjustable from 100 percent to 120 percent of nominal. Equalize voltage shall be adjustable up to 15 percent above float voltage. Output voltage adjustments shall be made from separate potentiometers. The charger shall incorporate automatic current limiting, and shall be capable of operating into a short circuit or dead battery indefinitely without damage or overheating. Charger shall have a 2-pole DC output circuit breaker.

F. Charger shall be filtered to minimize interference with load and control equipment. Ripple voltage shall be 150mV rms maximum. The charger shall incorporate a soft-start feature in which output is gradually increased from zero to full required output within 5 to 10 seconds.

G. Charger voltage regulation shall be within plus or minus 1 percent of the correct temperature compensated value from no load to full load with simultaneous variations in input voltage of plus or minus 10 percent and frequency of plus or minus 5 percent.

H. The charger shall incorporate automatic ambient temperature compensation to maximize battery performance and life. Temperature coefficient shall assure correct charging at all temperatures. Provisions shall be made for field retrofit of remote temperature compensation probe. Temperature compensation shall automatically revert to local sensing if the remote temperature probe is damaged or disconnected.

I. The charger shall include an automatic equalize feature that is activated when the battery's state of charge is reduced. A front panel switch shall be provided to enable manual selection of float, boost, or automatic modes.

J. Meters or indicators shall be provided for AC input voltage, AC input current, DC output voltage, and DC output current. Status indication of the charger and batteries shall be visible on the front panel. Means for manual testing of the status indicators shall be provided. Status indicators shall include AC on, float or boost mode, AC fail, low battery voltage, high battery voltage, and charger fail.

K. At a minimum Form C output contacts shall be provided for low battery voltage, ground fault, and common fail alarms. Time delay circuitry shall be provided on the output contacts.

L. Design criteria: Charger shall recharge a fully discharged battery at no more than 12 hours and must be sized to handle continuous load. The expected charger size is 12A at no more than 12 hours.

M. Acceptable manufacturers

1. Stored Energy Systems (SENS) Type DCT

2. Alcad Type SCRF

3. Approved equal

2.5 CONTAINMENT AND SPILL MITIGATION

A. Provide battery containment tray sized for the electrolyte volume required per the battery sizing criteria specified herein. Provide UL listed acid resistant tray made of polymer material.

B. Provide spill neutralizer mats designed with base neutralizer for potassium hydroxide electrolyte Ni-Cad batteries specified in this section. Mats shall cover the floor inside the battery containment area in order to provide continuous protection from electrolyte spills.

C. Acceptable manufacturers:

1. Enviroguard

2. ACRAN.

3. Or equal as approved by the Engineer.

2.6 DC PANELBOARD

A. Provide DC panelboard installed with the battery and charger for serving DC circuits in the switchgear.

B. Panelboard shall conform to the requirements of Section 16442 except breakers shall be rated for 125VDC minimum.

PART 3 EXECUTION

3.1 INSTALLATION

A. Batteries, rack, charger, panelboard, and appurtenances shall be installed inside the designated section of the outdoor switchgear enclosure as shown on the Drawings.

B. All equipment shall be firmly bolted to the appropriate surface to approved shop drawings.

C. Provide equipment anchorage to resist seismic forces as directed by the approved seismic calculations per Section 01612.

3.2 FIELD QUALITY CONTROL

A. Site Tests, Inspections

1. Acceptance testing shall be as specified in Section 16080.

END OF SECTION

SECTION 16260 – LOW VOLTAGE ADJUSTABLE SPEED DRIVE MOTOR CONTROLLERS

PART 1 GENERAL

1.1 DESCRIPTION

A. Work included:

1. Provide labor, equipment, supervision, and materials for the installation, testing, and start-up of the adjustable speed drive(s) (ASD) as shown on the Drawings and as specified herein.

2. Provide a manufactures technician to start-up each ASD. The technician shall be present during the field acceptance testing.

3. Where ASD's are provided as part of a packaged system, the system supplier shall indicate that the motor is suitable for operation with a ASD.

4. Perform harmonic analysis of ASD connected to the power distribution system.

5. The ASDs will operate motors as specified in Division 11. The drives furnished shall be certified compatible and certified for operation with the motors to be supplied.

B. Related Sections:

1. Section 11600 – Biosolids Dryer System

2. Section 13400 – Common Work Results Instrumentation and Controls

3. Section 16080 – Commissioning of Electrical Systems

4. Section 16220 – Low Voltage Motors

1.2 QUALITY ASSURANCE

A. ASDs shall utilize a field proven design. The ASD manufacturer shall demonstrate at least three years of continuous field operating experience with equipment of similar size and design.

B. Provide complete factory testing of the complete ASD equipment including power factor correction capacitors and network interface operation as specified herein.

C. A factory authorized service and parts organization shall be located within 150 miles of the project location. Provide the name and address of the factory authorized service and parts organization nearest to the project location at the time of the bid.

D. Equipment shall be UL or ETL labeled.

E. Manufacturer shall be ISO 9001 certified.

1.3 SUBMITTALS

A. Submit shop drawings and product data, in accordance with Section 01300 and 16000

B. Submit the following:

1. Equipment outline drawings showing elevation, plan and interior views, front panel arrangement, dimensions, and weight.

2. Product data sheets and catalog numbers for all integral components such as motor protection relays, motor starters, control relays, control stations, meters, pilot lights, etc. List all options, trip adjustments and accessories furnished specifically for this Project.

3. Indicate all options, special features, ratings, and deviations from the specifications.

4. Single line diagram, control schematics, and interconnection diagrams showing wire and terminal identification numbers. Provide diagrams detailing both internal and external connection points. Show wire numbers, terminal numbers, and color coding.

5. Submit certification that the drive provided shall meet the harmonic limitations as specified herein at the designated point of common coupling (PCC). Submit details of any filters, reactors, or other devices determined to be necessary to achieve the specified harmonic limits. Details shall include catalog cuts, dimensional information, and mounting requirements, conduit and wire sizing, and interconnection details.

6. Submit information demonstrating the drive output will not harm the motors through dV/dt reflected waves. Indicate specifically if output reactors will be required to protect the motors.

7. Submit certification of unit responsibility, that the ASD's are compatible with the motors they will be operating.

8. Network Communications Interface.

   a. Submit network module data sheets and memory mapping for devices resident within the assembly network. Submit device parameter list with all data variables available for remote monitoring over the network interface. List shall include variable internal name, descriptive field that fully describes the contents and use of the variable, memory address and bit size, variable type (analog, discrete, text), engineering units, and function (e.g., status, alarm, internal diagnostic, etc.). Include complete configuration instructions including addressing, register allocation, data mapping, and options.

   b. Network access requirements including method for accessing equipment variables, software features, and physical hardware interface details.

C. Submit anchorage calculations per the seismic criteria included in Section 01612.

D. Certified shop test reports

1. Submit manufacturer's standard factory testing procedure.

2. Submit network communications factory testing procedures including procedures for testing Ethernet interface communications. Procedures shall include method for 100% testing of all variables associated with each device. Procedure shall include factory test forms with sign-off sheets indicating proper transmittal and receipt of each variable, properly scaled, and addressed in conformance with the manufacturer's standard documentation. Include verification of each device I/P address conforming to City standards.

E. Submit field test and inspection reports.

1. Submit manufacturer's field commissioning and startup testing procedures conforming to Section 16080.

2. Submit detail and test plan for field verification of the network communications interface including verification of data receipt at the City's SCADA Central HMI per Section 13400.

3. Coordinate field testing with other testing requirements of Section 16080 including field harmonic testing.

4. Submit field testing and startup results

F. Operations and Maintenance Manuals

1. Submit operations and maintenance manuals, in accordance with 01700, as follows:

a. Instruction, installation, and maintenance manuals for all components provided.

b. Software configuration manuals.

c. As-built drawings for the complete ASD assemblies.

d. Itemized list of spare parts furnished specifically for this project including quantities, part numbers, and descriptions.

e. Complete listing of drive configuration parameters and settings for each drive furnished.

f. Detailed instructions for ASD network interface configuration and troubleshooting

1.4 MOTOR COMPATIBILITY

A. The ASDs shall be coordinated with the motors supplied under this contract. Motors operated by ASD's shall be inverter duty rated as specified in Section 16220.

1.5 UNIT RESPONSIBILITY

A. Provide unit responsibility for the ASDs in this section including electrical motor and driven equipment. The Contractor shall submit letters of certification with the shop drawings from the ASD manufacturer, the motor manufacturer, and the driven equipment manufacturer stating that they have reviewed each application and that the combination will satisfy the application duties required, for the actual motor sizes required, regardless of deviations from the scheduled "nominal horsepower."

B. Where a pump or package process system supplier is responsible for supplying the pump, motor and ASD as required in Division 11 or Division 13, the supplier shall coordinate the ASD and motor and provide certification that the driven equipment, motor, and ASD are compatible and will meet the system requirements of the application. Certification from the supplier shall state that they have reviewed application requirements and that the equipment, motor, and ASD combination will satisfy the application duties required, incorporating any deviations from the nominal horsepower shown on the Contract Documents.

1.6 PERFORMANCE

A. The ASDs shall be capable of operating any NEMA design B squirrel cage induction motor, regardless of manufacturer, with a horsepower and current rating within the capacity of the ASD.

B. Submit certification that the harmonics introduced by the ASD at the point of common coupling (PCC) shall meet the requirements of IEEE Std 519-2014 for General Systems. The Contractor shall determine the available short circuit value at the PCC based on the electrical short circuit study performed under Section 16080. PCC shall be defined as the main bus of MCC D1 as provided by the Dryer System Supplier per Section 11600 or main bus of DPC1 for the Filter Feed Pump ASD as applicable

C. During power outage, the ASD shall cease output to the motor and, upon restoration of power supply, shall have the capability to restart, catch, and reaccelerate the spinning motor to its original speed without damaging the motor.

D. The ASD shall start, accelerate, and operate the motor through the specified speed and load range with an input voltage variation of ±10% from nominal and an input frequency variation of ±5% from nominal.

E. Unless otherwise specified, the power electronic system shall comply with the emissions and immunity limits as defined in 6.5.2.2 and 6.5.2.3 of IEC 61800-3-2004.

1.7 DELIVERY, STORAGE AND HANDLING

A. Package the equipment for maximum protection during delivery and storage.

B. Store the equipment indoors in a clean, dry, heated storage facility until ready for installation. Do not install the equipment in its final location until the facilities are permanently weather tight. Furnish, install, and wire temporary electric space heaters in the equipment until the permanent heating equipment is operational. Protect the equipment at all times from exposure to moisture and chemicals.

1.8 REFERENCE STANDARDS

A. IEEE Standard 519 (2014) – "IEEE Recommended Practices and Requirements for Harmonic Control in Electrical Power Systems."

B. National Electrical Code (NFPA 70) latest edition.

C. Underwriters Laboratories (UL)

D. Where reference is made to one of the above standards, the revision in effect at the time of bid opening shall apply.

1.9 PROJECT/SITE REQUIREMENTS

A. The ASD shall not produce motor noise in excess of the manufacturers published noise standards for 60-Hz operation.

B. The ASD shall be capable of continuous operation in an ambient temperature range between 0°C and 40°C.

1.10 SPARE PARTS

A. Provide the following spare parts for each size drive in the quantities specified:

1. One of each type printed circuit board.

2. Two power diodes.

3. One pair power transistors.

4. 50 percent replacement fuses, all types, and sizes.

5. One operator interface module.

6. Two replacement LEDs for pilot lights of each color and type.

B. Spare parts shall be boxed or packaged for long term storage. Identify each item with manufacturers name, description, and part number on the exterior of the package.

1.11 MANUFACTURER'S FIELD SERVICES

A. The Manufacturer shall furnish a service representative for the equipment and materials furnished under these specifications. The service representative shall be technically competent, factory trained, experienced in the installation and operation of the equipment, and authorized by the manufacturer to perform the work stipulated.

B. Provide setup, startup and commissioning services performed by the service representative as specified under Section 11600.

PART 2 PRODUCTS

2.1 ACCEPTABLE MANUFACTURES

A. Manufactures: Subject to compliance with these specifications, the typical equipment, systems, and accessories installed shall be manufactured by:

1. Allen Bradley, PowerFlex 700 or 755T
2. Square D, Aptiva
3. GE, AF-6
4. Approved equal

2.2 RATING

A. Service Conditions

1. Input power: 460 VAC, ±10 percent, 3 phase, 60 Hz.
2. The ASD shall have a continuous output current rating equal to or greater than the motor full load nameplate current.
3. Input frequency: ±5%
4. Ambient temperature: 0 degrees C to 40° C.
5. Elevation: Up to 3300 feet above mean sea level.
6. Relative humidity: Up to 90% non-condensing.

B. Minimum drive efficiency: 95% or better at full load.

C. Displacement power factor: 0.95 or higher throughout the entire speed range, measured at drive input terminals.

D. Drive output: 100 percent rated current continuous, suitable for operation of the driven equipment over the required speed range without overloading. Drives shall be capable of a continuous overload up to 110 percent rated current for 60 seconds for variable torque loads and 150 percent rated current for constant torque loads. Starting torque shall be matched to the load.

E. Output frequency drift: No more than plus or minus 0.5 percent from setpoint.

F. Drives shall withstand five cycle transient voltage dips of up to 15 percent of rated voltage without an undervoltage trip or fault shutdown, while operating a variable torque load.

2.3 CONSTRUCTION

A. General

1. The ASDs shall be 18 pulse technology or have an active means to eliminate resonance on the grid. Technology shall reduce the low order harmonic current to meet IEEE Std. 519 criteria at the input terminal of the drive. The ASD's shall utilize a digital pulse width modulated (PWM) design to convert the fixed AC input to a variable voltage, variable frequency AC output.

2. Provide common mode voltage suppression.

3. The ASD shall operate satisfactorily when connected to a bus supplying other solid-state power conversion equipment which may be causing up to 10 percent total harmonic voltage distortion and commutation notches up to 36,500 volt microseconds, or when other ASD's are operating from the same bus. Provide transient voltage suppression to allow reliable operation on a typical industrial power distribution system.

4. The ASD shall consist of a full-wave diode bridge converter to convert incoming fixed voltage/frequency to a fixed DC voltage. Provide a DC link choke smoothing reactor to limit fault throughput.

5. Drive shall have been tested to and UL listed as conforming to the requirements of UL508C at rated load currents and ambient temperature per this specification. Drive shall have a UL listed interrupting rating of 65kAIC minimum.

6. The ASD shall have an output voltage regulator to maintain correct output Volt/Hertz despite incoming voltage variations. The ASD shall be 18 pulse with a phase shifting integral auto-transformer or provide active front end including an active means to eliminate resonance. Provide specified front end device to reduce voltage and current harmonics transmitted to the plant power distribution system.

7. The enclosure shall be metal, free standing, front maintenance type with top or bottom conduit entry for power, control, and motor cables. The enclosure shall be NEMA 12 gasketed and filtered,

8. Provide fans and a thermostat to maintain the internal temperature of the drive unit based on ambient temperature limits and include a thermostatically controlled condensation space heater.

9. The ASD shall include a molded case circuit breaker to provide a disconnect means. Operating handle shall be flange mounted. The disconnect shall not be mounted on the door. The handle position shall indicate ON, OFF, and TRIPPED condition. The handle shall have provisions for padlocking in the OFF position with at least three (3) padlocks. Interlocks shall prevent unauthorized opening or closing of the ASD door with the disconnect handle in the ON position.

B. Operator interface

1. Provide a door-mounted digital keypad/display, capable of controlling the drive and setting drive parameters. The digital display shall normally display:

   a. Speed demand in percent

   b. Output current in amperes

   c. Frequency in Hertz

   d. Control mode - manual or automatic

2. The digital keypad shall allow operators to enter exact numerical settings in English engineering units. A user menu shall be provided as a guide to parameter settings. Coded messages on keypad will not be acceptable. Parameters are to be factory set in EEPROM and resettable in the field. Parameters shall be password protected. The EEPROM stored variables shall be transferable to new and spare boards.

3. The keypad/display module shall have a key switch to control operation of the keypad. The key shall be removable in either the "Enabled" or "Disabled" positions. The keypad module shall contain a "self-test" software program that can be activated to verify proper keypad operation. The keypad display shall contain a full alphanumeric character set.

4. At a minimum, the following controls and indicators shall be provided, either separately or as part of the keypad/display:

   a. POWER ON, RUN AND FAULT indication.

   b. FAULT RESET control.

   c. LOCAL-OFF-REMOTE control mode selector.

   d. Manual START/STOP controls.

   e. Manual speed adjust capability.

C. Auxiliary Contacts

1. Provide two set(s) of Form C auxiliary dry contacts for remote indication of ASD running status.

2. Provide two set(s) of Form C auxiliary dry contacts for remote indication of ASD fault.

D. Auxiliary Power: Provide 120 VAC and 48VDC auxiliary power on drive terminal strips for use in powering auxiliary control devices.

2.4 BYPASS CONTACTOR

A. Where shown on the Drawings provide an ASD bypass motor starter contactor to allow motor starting and operation as a full speed upon failure of the ASD unit. Provide two contactor bypass rated for motor full load amps as shown on the Drawings. Provide bypass contactor installed integral with the ASD controller with bypass controls implemented per the Control Schematic Diagrams

2.5 PROTECTIVE AND OPERATIONAL FEATURES

A. Make provisions for field adjustment of the following parameters through the keypad/display:

1. Current limit and boost.
2. Voltage (Volts/Hertz.)
3. Frequency (Minimum and Maximum)
4. Independently adjustable acceleration and deceleration rates.
5. Auto restart delay.
6. Up to five critical bands where drive operation is inhibited.

B. Make provisions to accept a remote dry contact closure to start and stop the drive(s) with the drive control system in the REMOTE mode.

C. Make provisions to accept a 4-20 mA DC input signal for remote speed control. Input shall be isolated at the drive and active with the drive control system in the AUTO mode. Zero and span adjustability shall be provided.

D. Provide a 4-20 mA DC isolated output signal proportional to speed for remote speed indication.

E. Provide the following short circuit and input protective features.

1. Input circuit breaker.
2. Solid state instantaneous overcurrent trip.
3. Undervoltage protection with automatic restart.
4. Ground fault protection.

F. Provide the following internal protective features.

1. Transient surge protection.
2. Overcurrent protection.
3. Current limit, inverse time type.

4. DC bus fuse protection and discharge circuit.

5. DC bus overvoltage trip.

G. Provide the following output protective features.

1. Inverse time motor overload protection.

2. Provide output dV/dt filters for any drive separated by more than 200 circuit feet from the driven motor, where shown on the Drawings, or where specified. The cost to provide the filters shall be included in the bid price including any additional motor control center sections necessary to house the additional filters.

H. Harmonic and Radio Noise Mitigation

1. Provide EMI/RFI filters to limit radio frequency noise in excess of the limits specified by FCC Docket 20780 (Part 15, Subpart J) or if the drives create noise in a frequency range which will interfere with other sensitive equipment at the installation (such as lighting systems, telecommunications systems, instrumentation, and monitoring equipment).

2.6 DIAGNOSTIC AND FAULT CAPABILITY

A. The following conditions shall cause an orderly drive shutdown and lockout.

1. Incorrect phase sequence.

2. Blown input fuse or single phasing of supply.

3. Control power supply failure.

4. Instantaneous overcurrent.

5. Sustained overload.

6. Transistor overcurrent.

B. Provide complete built-in diagnostic and test capability to enable maintenance personnel to rapidly and accurately identify the cause of equipment failure.

2.7 COMMUNICATIONS

A. Provide Ethernet, Modbus TCP interface integrated in the ASD in accordance with UL procedures and practices. Ethernet, Modbus TCP implementation requirements shall be as specified in Section 13400.

B. Each drive shall communicate via Ethernet, Modbus TCP, and monitor all available ASD parameters and shutdown conditions per the ASD standard interface or motor protection relay.

C. The Ethernet, Modbus TCP data communications shall be fully integrated into the unit. The Ethernet, Modbus TCP system shall be installed, configured, and tested prior to on-site installation. All Ethernet, Modbus TCP network transmission media shall be provided for a complete system, including network cable, terminations, switches, and all required network hardware.

D. Ethernet, Modbus TCP network cable shall be Category 5 or better and conforming to the requirements of UL 845. Ethernet, Modbus TCP cable shall have an insulating rating equal to at least the maximum circuit voltage applied to any conductor within the enclosure or raceway. Special separation, barriers, or internal conduit for the Ethernet, Modbus TCP conductors are not acceptable.

E. The Ethernet, Modbus TCP address shall be assigned to each unit during factory configuration. I/P addressing shall conform to City standards as specified in Section 13400.

F. Provisions for plugging in a laptop for configuration of the ASD for communication shall be included.

2.8 SURFACE PREPARATION AND SHOP COATINGS

A. All non-current carrying metal parts of the equipment cabinet shall be cleaned of all weld spatter and other foreign material and given a heat cured, phosphatized chemical pre-treatment to inhibit rust.

B. Unpainted non-current carrying parts shall receive a protective zinc plating to prevent corrosion. Printed circuit boards shall be coated with a protective conformal epoxy. All device contacts shall be silver cadmium plated.

PART 3 EXECUTION

3.1 INSTALLATION

A. Install the equipment in accordance with the manufacturer's instructions.

3.2 FACTORY QUALITY CONTROL

A. Provide manufactures standard factory test.

B. Confirm proper operation of the network communications following the favorably reviewed testing procedures for testing the network interface communications including addressing of all monitored variables to preassigned registers.

3.3 FIELD QUALITY CONTROL

A. The Contractor shall provide acceptance testing of the ASD’s per NETA guidelines for ASD’s and per the requirements of Section 16080.

B. Confirm proper operation of the network communications following the favorably reviewed testing procedures for testing the network interface communications including delivery of all monitored variables to preassigned registers and confirmed at the plant SCADA system per Section 13400.

C. Where ASD's are part of a mechanical system package, the manufactures representative shall coordinate the acceptance test with the package supplier and the Contractor. Refer to Sections 11600.

3.4 ADJUSTMENT

A. Make all ASD internal adjustments and all adjustments necessary for manual and automatic operation of the entire system of driven equipment.

3.5 CLEANING

A. Remove all rubbish and debris from inside and around the equipment. Remove dirt, dust, or concrete spatter from the interior and exterior of the equipment using brushes, vacuum cleaner, or clean, lint-free rags. Do not use compressed air.

3.6 TRAINING

A. The Contractor shall provide two training sessions of a minimum of 4 hrs during normal workdays with a maximum of 1 trip. Training location to be determined by the City. Training and instruction time shall be in addition to that required for start-up service and shall be included in the bid price.

B. The manufacturer's qualified representative shall conduct the training.

C. The training program shall consist of the following:

1. Instructions on the proper operation of the equipment.

2. Instructions on the proper maintenance of the equipment.

D. Where ASD's are part of a mechanical system package, training shall be included with the package system. Refer to Sections 11600.

END OF SECTION

SECTION 16263 – STATIC UNINTERRUPTIBLE POWER SUPPLIES (UPS)

PART 1 GENERAL

1.1 SCOPE OF WORK

A. Furnish and install the static uninterruptible power supply (UPS) including: converter, inverter, storage batteries, external maintenance bypass, system controls, panelboards, circuit breakers, accessories, and appurtenances as shown on the Contract Documents.

B. Provide configuration and test UPS equipment including UPS network communications.

1.2 RELATED SECTIONS

A. Section 01612 – Seismic Design Criteria

B. Section 16000 – Common Work Results for Electrical

C. Section 16080 – Electrical System Analyses and Commission Field Testing

D. Section 16441 – Panelboards

1.3 SUBMITTALS

A. Submittals shall be made in accordance with Section 01340 and Section 16000.

B. Submit a complete list of equipment and materials and any details required to demonstrate that the equipment will function properly as a unit. The following information shall be provided:

1. Manufacturer's descriptive and technical literature. Indicate all optional equipment being provided to achieve compliance with these Specifications.

2. System configuration with single-line diagrams. Identify devices by location, frame size, trip rating, and manufacturer type number.

3. Detailed descriptions of equipment, including weights, dimensions, foundations, foundation requirements, and installation and anchoring requirements.

4. Complete dimensional plan views of all major components indicating cable entry, sizes, weight, and clearances required for equipment.

5. Bus arrangement, material, ratings and insulation details.

6. Interconnection and schematic diagrams for power and control wiring for all major components. Show all conduit runs and wiring with terminal numbers for each wire. All contacts, terminal blocks and wire numbers for remote devices shall be clearly identified. Show field devices and wiring diagrams.

7. Calculations for sizing batteries based on the load and duration requirements as specified herein. State all assumptions.

8. Calculations for sizing the UPS kilovolt amperes (kVA) rating.

9. Cabinet outline and interconnection drawings shall be dimensioned and scaled, and include the following information:

    a. Location of any removable plates for conduit entry.

    b. Location and size of all terminal blocks for remote circuit connection.

    c. Location and size of ventilation openings including any required clearances to assure equipment cooling.

    d. Location of cabinet grounds.

    e. Electrical working space clearances as required per the NEC.

10. Block diagram including currents for customer cable sizing, breaker location and sizes, and meter locations.

11. Nominal heat loss, size and weight for equipment.

12. Front operator interface panel: explanatory diagram including identification and function of all switches, interface screens, and control components.

13. Schematic type drawings shall include the following information:

    a. System schematics shall include item designations for all electrical components.

    b. Relay contacts diagrams shall be shown in the de-energized position.

    c. Wire sizes and numbers shall have the same designation that appears in the equipment.

C. Submit details of the network communications interface. Submit network module data sheets and memory mapping. Submit device parameter list with all data variables available for remote monitoring over the network interface. List shall include variable internal name, descriptive field that fully describes the contents and use of the variable, memory address and bit size, variable type (analog, discrete, text), engineering units, and function (e.g., status, alarm, internal diagnostic, etc.). Include complete configuration instructions including addressing, register allocation, data mapping, and options.

D. Submit copies of certified factory test reports for review.

E. Submit the results of the site test for review per Section 16080, Electrical Field Testing.

F. Anchorage design calculations shall be in accordance with Section 01070.

1.4 REFERENCE STANDARDS

A. General

1. The publications listed below form a part of this specification to the extent referenced.

2. Where a date is given for referenced standards, the edition of that date shall be used. Where no date is given for the reference standards, the latest edition available on the date of the Notice Inviting Bids shall be used.

B. Institute of Electrical and Electronics Engineers (IEEE)

1. IEEE C62.41 – IEEE Recommended Practice for Surge Voltages in Low-Voltage AC Power Circuits.

C. National Fire Protection Association (NFPA)

1. NFPA 70 – National Electrical Code (NEC).

D. Underwriters Laboratories (UL)

1. UL 1778, Standard for UPS Equipment.

E. International Electrotechnical Commission (IEC)

1. IEC 62040-2, UPS – Part 2: Electromagnetic compatibility (EMC).

1.5 SYSTEM DESCRIPTION

A. The UPS shall be designed to operate continuously at rated capacity as an on-line, automatic system in the following modes:

1. Normal – The inverter continuously supplies Alternating current (AC) power to the critical load. The converter converts commercial AC power to regulated direct current (DC) power which then serves as the inverter input and, simultaneously, as a float charge input to the storage battery.

2. Emergency – In the event of a commercial AC power failure, the inverter shall derive its input from the system battery, providing uninterrupted power to the critical load. This transition shall be accomplished without any switching or coupling, and with no interruption of power to the critical load from either a failure or restoration of the commercial AC power. Provide minimum of 1 hour battery operation time at rated output.

3. Recharge – Subsequent to restoration of commercial AC power, the converter shall automatically reactivate and provide DC power to the inverter, simultaneously recharging the system battery, automatically and without interruption to the critical load.

4. Bypass – In the event that the UPS must be taken off line due to an overload condition or UPS failure, the critical load shall be transferred to the bypass source via the static transfer switch without interruption of power to the critical load. The static transfer switch shall only be utilized for automatic emergency transfers. A re-transfer from bypass to inverter shall be performed automatically in overload conditions. A re-transfer shall be inhibited if satisfactory synchronization of the inverter and bypass is not accomplished.

5. Maintenance Bypass – The UPS system shall be equipped with an external maintenance bypass switch (MBS) to allow safe and reliable maintenance of the UPS. The MBS shall be of the Make-Before-Break, zero energy type circuit breaker.

B. Provide UPS system having published reliability metrics in terms of theoretical Mean-Time-Between-Failures (MTBF) of:

1. Total single module UPS system output (includes reliability of bypass circuit): 3,000,000 MTBF hours.

2. Single module UPS operation (represents UPS module operation only): 140,000 MTBF hours.

1.6 MAINTENANCE

A. Submit instruction (operation and maintenance) manuals shall describe the equipment in full and shall include the following major items:

1. Operating instructions and start-up procedures including receiving and installation requirements.

2. Maintenance instructions listing preventative and corrective maintenance procedures. Corrective maintenance procedures shall identify the most probable failures and the appropriate repairs. Test measurement levels shall be referenced to specific test points on the installed equipment.

3. Spare parts shall be furnished for each item of material and equipment specified. The data shall include a complete list of parts and supplies, with current unit prices and source of supply. A list and itemized price breakdown of spare parts recommended for stocking shall be furnished. The parts selected shall be those which, in the manufacturer's judgment, will be involved in the majority of maintenance problems.

4. Catalog cuts and technical manuals for all components of the system.

5. Copies of all guarantees and warranties issued for the various items of equipment, showing all dates of expiration.

6. Copies of all test results.

7. Final copies of all shop drawings, incorporating manufacturing and field changes.

B. Spare Parts and Accessories

1. Furnish the following maintenance accessories:

a. One compete set of special tools as required for installation and/or maintenance.

b. Special tools as required for performing electrical system checks. Provide tester as required to check input and bypass voltage and phase rotation; battery polarity and voltage; output voltages; and synchronization.

2. Provide the following spare parts specified:

a. Provide spare printed circuit board components and critical solid state equipment that are field replaceable as defined by the manufacturer.

b. Three complete replacement sets of fuses of each different size and type.

c. One dozen each of cover bolts, nuts and special hardware.

d. One refinishing kit for field touch-up of paint.

3. Spare parts shall be boxed or packaged for long term storage and clearly on the exterior of the package. Identify each item with manufacturer's name, description and part number.

PART 2 PRODUCTS

2.1 GENERAL

A. The Contractor shall furnish and install a complete and functional static UPS system as shown on the Drawings and according to these specifications. The general arrangement of the UPS shall be maintained as near as possible to that shown on the Drawings.

B. The UPS system shall include a converter, system battery, solid-state inverter, and external maintenance bypass circuit.

C. Input and output power shall be hardwired to the UPS.

D. The UPS shall be suitable for locations as shown on the Drawings.

E. Acceptable Manufacturers: Eaton Model 9390; Liebert; APC; or equal.

2.2 UPS

A. The UPS system shall be designed in accordance with the following conditions:

1. Duty: Continuous

2. Primary UPS Input:

a. Voltage: 208 Volts AC, 3-phase, 3-wire, as shown on the Drawings.

b. Frequency: 60 Hertz ± 5 percent.

c. Reflected input current total harmonic distortion (THD): 4% maximum at 100% load.

3. UPS Output:

a. Voltage: 208 Volts AC, 3-phase, 4-wire.

b. Nominal dynamic voltage regulation: ± 2% for unbalanced loads.

c. Voltage transient response: Not to exceed the following, and shall recover to within nominal voltage regulation limits within 16.7 ms:

1) ± 3% for a 100% load step.

2) ± 1% (loss of return of AC input).

3) ± 3% (inverter to/from bypass).

d. Free running output frequency (on battery or asynchronous): 60 Hertz ± 0.01%.

e. Output voltage harmonic distortion:

1) 2% THD maximum with 100% linear load.

2) 4% THD maximum with 100% non-linear load.

f. Output overload capability: 150% for 1 minute (voltage regulation maintained).

g. Output fault clearing: Typically 1000/5 for 1 cycle (with bypass available).

4. DC Input

a. Voltage: 208 Volts DC nominal, 208 Volts DC minimum.

b. Voltage ripple under normal operation: less than 2 percent of DC voltage.

c. Float Voltage: 250 Volts DC (2.25 to 2.27 Volts per cell)

d. Final Voltage: 190 Volts DC (1.67 Volts per cell).

5. Efficiency:

a. Minimum 94.9% at 50% load.

b. Minimum 95.6% at 100% load.

6. Voltage adjustability: +5 to -5 percent.

7. Minimum silicon-controlled rectifier (SCR) rating: 50 percent from peak voltage and current ratings.

B. Minimum UPS sizes are shown in the Contract Documents. However, specific UPS units shall be provided as required to adequately power the loads indicated on the Drawings plus 15% for future loads. Provide the next larger manufacturer's standard size of UPS when the calculated load falls between standard size ratings.

C. Enclosures

1. Equipment enclosures for UPS and batteries shall be free-standing floor mounted NEMA Type 1 gasketed, ventilated, cabinets designed for indoor service. The UPS shall be located against a wall in the plant as indicated on the Drawings and shall be constructed for front access only.

2. Components shall be mounted so that they can be easily maintained without disassembly or dismounting adjacent equipment. Subassemblies shall be modular to facilitate maintenance and replacement.

3. Provide ventilation louvers, openings, and enclosure panels sufficient to maintain equipment cooling within manufacturer's tolerances. All vent openings shall be covered with corrosion-resistant fine screen coverings or other protection against entry of dust, insects, etc.

2.3 CONVERTER

A. The converter shall convert the incoming AC power into regulated DC power to supply the inverter input and system battery. The converter shall utilize solid state pulse width modulating (PWM) controlled insulated gate bipolar transistor (IGBT) power transistors.

B. The converter logic shall provide input current limiting by limiting the AC input current. Three line-side current transformers shall be employed as a means of sensing the current amplitude. It shall provide sufficient capacity to provide power to a fully loaded inverter while simultaneously recharging the system battery to 90% of full capacity within 10 times the discharge time. The converter logic shall provide DC battery current limiting for controlled battery charging. The battery current sensing shall be independent of the converter DC output current sensing.

C. The converter logic shall employ circuitry to allow a delayed and timed ramping of input current. Subsequent to energizing the converter input, the ramping of current shall be delayed by a maximum of 3 seconds. Ramping of current shall be timed to assume the load gradually within 20 seconds.

D. Provide an input AC circuit breaker or fuse/contactor arrangement for input overload isolation protection.

E. 100% step load changes shall use only the converter to supply power to the inverter. The batteries shall not be cycled at any time during step load changes.

2.4 INVERTER

A. The inverter shall generate AC power that is derived from DC power supplied from the converter or the system battery. The inverter shall be capable of providing the rated output while operating from any DC voltage within the battery operating range. The inverter shall utilize solid state PWM controlled IGBT power transistors.

B. The inverter output frequency shall be controlled by an oscillator internal to the UPS module logic. It shall be capable of synchronizing to an external reference (e.g., the bypass source) or operating asynchronously. The oscillator shall maintain synchronization with the external reference within the limitations set forth herein. The inverter output frequency shall not vary during steady state or transient operation.

C. The inverter output shall be capable of providing an overload current while maintaining specified output fault clearing. Load current above the specified overload limit shall cause an immediate transfer of the load to the bypass source for fault clearing.

D. The inverter AC output shall utilize electronic current limiting for overload conditions. The inverter shall utilize a contactor to isolate its input from the critical bus. The inverter DC fuses shall be the fast acting semiconductor type to clear faults on the DC bus. The inverter output isolation contactor shall be located internal to the UPS module and shall be controlled by the internal UPS module system logic.

2.5 STORAGE BATTERY

A. Provide valve regulated lead acid (VRLA) storage batteries. The batteries shall be suitable for indoor environment with no gassing, watering, or special ventilation required. Each battery shall have a nominal system voltage as required by continuous AC power supply.

B. The battery capacity shall be determined by the Contractor based on the load and duration requirements. The battery system shall be sized to operate at 100% of the UPS rated load for a minimum of 30 minutes. If required to provide this run time, provide a separate battery cabinet, similar in construction to the UPS cabinet, to house additional batteries.

C. The total electrolyte volume of the UPS battery system shall not exceed 50 gallons.

D. A circuit breaker rated for the proper DC voltage and final discharge ampacity shall be furnished with the UPS module. This circuit breaker shall be placed at the output of the storage battery. The circuit breaker shall be selected and furnished to coordinate with the battery cable sizing.

E. Provide all necessary accessories including, but not limited to, battery monitoring system for thermal runway management, spill clean-up kit, ventilation, and signage, as required for compliance with the California Fire Code. Battery monitor shall be housed in a separate enclosure and mounted within the battery cabinet.

2.6 UPS CONTROLS

A. The following controls shall be included on, or inside of, the UPS module cabinet:

1. On-Off Controls: Start/Stop; Clear (reset); Emergency Power Off (EPO)

2. Indicators: Battery Operation; UPS Failure; Converter On/Off; Load on Inverter; Load on Bypass

B. Provide digital displays for monitoring UPS parameters. All readings shall have an accuracy of 1% or better. The following parameters shall be available for display:

1. Converter input voltage (all phases)

2. Converter input current

3. Converter input frequency

4. Input effective power (real, kilowatts)

5. Battery voltage

6. Battery charging/discharging current

7. Battery capacity remaining during power failure conditions

8. Output voltage (all phases)

9. Output current in RMS amps (all phases)

10. Load effective power (real, kilowatts)

11. Output frequency

C. The UPS shall provide microprocessor controlled diagnostics capable of retaining fault alarms along with metering parameters in the event of a UPS failure. The microprocessor memory data shall be viewed via an LCD display located on the front of the UPS. The following alarm/status information shall be provided as a minimum:

1. Inverter Operation

2. Inverter Start/Stop

3. Battery Operation

4. Battery Low Voltage

5. Output Overload

6. Battery Depleted

7. Battery Temperature Abnormal

8. Converter Operation

9. Converter Supplying DC Power

10. Converter Input out of Range

11. Inverter Stop due to Overload Condition

12. Inverter Running Synchronously

13. Inverter Running Asynchronously

14. UPS on Static Bypass

15. Static Bypass Input out of Range

16. Minor Fault

17. Major Fault

18. Inverter Output Condition (open or closed)

19. Battery Charge/Discharge Operation

D. Provide normally open, A-type dry contact outputs for remote monitoring for each UPS:

1. Load On Inverter

2. Load In Bypass

3. Load On Battery

4. Battery Low Voltage

5. Converter Operating

6. Output Overload

7. Malfunction Alarm

2.7 COMMUNICATION INTERFACE – NOT USED

PART 3 EXECUTION

3.1 FACTORY TESTING

A. Prior to shipment, the completed equipment shall undergo manufacturer's standard factory testing.

B. Certified reports on the tests shall be submitted to the Engineer for review and approval prior to shipment.

C. Copies of the test reports shall be included in the instruction manuals for each component and shall be identified by serial number.

D. The Contractor shall furnish all the necessary labor, material, equipment, and all other necessary test equipment. The Contractor shall perform all assembling, testing and reporting required herein.

E. The entire system shall be operated under rated conditions for a minimum 96-hour burn-in after which it shall be subjected to the following tests:

1. Simulate an inverter failure which causes the load to transfer to the bypass source.

2. Restore the inverter to permit the transfer back to the normal source.

3. Simulate a battery failure.

4. Short circuit the output of the system to demonstrate the current-limit effect of the inverter.

5. Simulate UPS module failure causing transfer to the alternative UPS.

6. Simulate full UPS system failure resulting in transfer to the back-up normal source

F. Factory test procedures shall include verification of the communication interface Ethernet device addressing and transmission of all UPS data to a suitably configured manufacturer's laptop or other computer.

G. Any corrections or adjustments to the equipment that may be required to demonstrate the above shall be made by the Contractor.

3.2 INSTALLATION

A. The uninterruptible power supplies, battery enclosures, and ancillary equipment shall all be installed in accordance with manufacturer's recommendations and in accordance with the seismic anchoring requirements specified.

B. Remove temporary lifting angles, lugs and shipping braces. Touch-up damaged paint finishes.

C. Make wiring interconnections per installation drawings.

D. Apply arc flash warning labels in accordance with Section 16080.

E. Access doors and shall open and close freely. Roll out components shall be able to be withdrawn smoothly without stress on rollers or slides. Repair all damage to the enclosure, components, or finish.

3.3 FIELD TESTING

A. Prior to testing, submit test procedure to Engineer for review. Following installation of the UPS system, the Contractor shall test its operation and demonstrate that all components protective devices, transfer devices, and control devices function properly. The Contractor shall make all adjustments required for correct operation per the requirements of Section 16080.

B. Confirm proper operation of the network communications following the favorably reviewed testing procedures for testing the network interface communications including delivery of all monitored variables to preassigned registers and confirmed at the plant SCADA system per Section 13400.

3.4 CLEANING

A. Remove all rubbish and debris from inside and around the equipment. Remove dirt, dust, or concrete spatter from the interior and exterior of the equipment using brushes, vacuum cleaner, or clean, lint-free rags. Do not use compressed air.

B. Apply touch-up paint so that all equipment is free from gouges, scratches, or other finish blemishes that occurred during shipping or installation.

3.5 TRAINING

A. Provide the services of a factory trained field engineer for training at the Project site in accordance with Section 01700. Training shall include instructions on adjusting, servicing and maintaining the static UPS system. The field engineer shall be at the site as specified in these Specifications.

END OF SECTION

SECTION 16265 – LOW VOLTAGE REDUCED VOLTAGE SOLID STATE STARTERS

PART 1 GENERAL

1.1 DESCRIPTION

A. Work included:

1. Provide labor, equipment, supervision, and materials for the installation, testing, and start-up of the 480V reduced Voltage Solid State (RVSS) motor starters as shown on the Drawings and as specified herein.

2. Provide a manufactures technician to start-up each RVSS. The technician shall be present during the field acceptance testing.

3. Coordinate the size of the enclosure foot prints with the size of the equipment pads.

4. Provide RVSS communications network and interface to the process control system per Section 13400.

B. Related Sections:

1. Section 11502 – Geared Single Stage Centrifugal Blower Packages

2. Section 11600 – Biosolids Dryer System

3. Section 13550 – Aeration Control System

4. Section 13400 – Common Work Results Instrumentation and Controls

5. Section 16000 – Common Work Results for Electrical

6. Section 16080 – Commissioning of Electrical Systems

7. Section 16220 – Low Voltage Motors

1.2 QUALITY ASSURANCE

A. RVSS shall utilize a field proven design. The RVSS manufacturer shall demonstrate at least three years of continuous field operating experience with equipment of similar size and design.

B. Provide complete factory testing of the complete RVSS equipment including power factor correction capacitors and network interface operation as specified herein.

C. A factory authorized service and parts organization shall be located within 150 miles of the project location. Provide the name and address of the factory authorized service and parts organization nearest to the project location at the time of the bid.

D. Equipment shall be UL or ETL labeled.

E. Manufacturer shall be ISO 9001 certified.

1.3 SUBMITTALS

A. Submit shop drawings and product data, in accordance with Section 01300 and 16000.

B. Submit the following:

1. Equipment outline drawings showing elevation, plan and interior views, front panel arrangement, dimensions, and weight.

2. Product data sheets and catalog numbers for all integral components such as motor protection relays, motor starters, control relays, control stations, meters, pilot lights, etc. List all options, trip adjustments and accessories furnished specifically for this Project.

3. Indicate all options, special features, ratings, and deviations from the specifications.

4. Single line diagram, control schematics, and interconnection diagrams showing wire and terminal identification numbers. Provide diagrams detailing both internal and external connection points. Show wire numbers, terminal numbers, and color coding.

5. Submit details of power factor correction capacitors including rating, enclosure details, control contactor switching, and incorporation of capacitor control logic in the overall RVSS control schematics. Details shall include catalog cuts, dimensional information, mounting requirements, conduit and wire sizing, and interconnection details.

6. Network Communications Interface.

a. Submit network module data sheets and memory mapping for starters and other devices resident within the assembly network. Submit device parameter list with all data variables available for remote monitoring over the network interface. List shall include variable internal name, descriptive field that fully describes the contents and use of the variable, memory address and bit size, variable type (analog, discrete, text), engineering units, and function (e.g., status, alarm, internal diagnostic, etc.). Include complete configuration instructions including addressing, register allocation, data mapping, and options.

b. Network access requirements including method for accessing equipment variables, software features, and physical hardware interface details.

C. Submit anchorage calculations per the seismic criteria included in Section 01612.

D. Certified shop test reports

1. Submit manufacturer's standard factory testing procedure.

2. Submit network communications factory testing procedures including procedures for testing Ethernet interface communications. Procedures shall include method for 100% testing of all variables associated with each motor starter, motor protection relay, power monitor, and other equipment associated with the medium voltage motor controller as specified. Procedure shall include factory test forms with sign-off sheets indicating proper transmittal and receipt of each variable, properly scaled, and addressed in conformance with the manufacturer's standard documentation. Include verification of each device I/P address conforming to City standards.

E. Submit field test and inspection reports.

1. Submit manufacturer's field commissioning and startup testing procedures conforming to Section 16080.

2. Submit detail and test plan for field verification of the network communications interface including verification of data receipt at the City's SCADA Central HMI per Section 13400.

3. Coordinate field testing with other testing requirements of Section 16080.

4. Submit field testing and startup results

F. Operations and Maintenance Manuals

1. Submit operations and maintenance manuals, in accordance with 01700, as follows:

a. Instruction, installation, and maintenance manuals for all components provided.

b. RVSS software configuration manuals.

c. As-built drawings for the complete RVSS assemblies.

d. Itemized list of spare parts furnished specifically for this project including quantities, part numbers, and descriptions.

e. Complete listing of RVSS configuration parameters and settings.

f. Detailed instructions for RVSS network interface configuration and troubleshooting

1.4 PERFORMANCE

A. The RVSSs shall be capable of operating any NEMA design B squirrel cage induction motor, regardless of manufacturer, with a horsepower and current rating within the capacity of the RVSS.

1.5 DELIVERY, STORAGE AND HANDLING

A. Package the equipment for protection during delivery and storage.

B. Store the equipment indoors in a clean, dry, heated storage facility until ready for installation. Do not install the equipment in its final location until the facilities are permanently weather tight. Furnish, install, and wire temporary electric space heaters in the equipment until the permanent heating equipment is operational. Protect the equipment always from exposure to moisture and chemicals.

C. Lift and place equipment in accordance with manufacturer's recommendations. Lift only be installed lifting eyes (if available) or other suitable means to protect equipment, devices, and finish.

1.6 REFERENCE STANDARDS

A. National Electrical Code (NFPA 70) latest edition.

B. Underwriters Laboratories (UL)

C. Where reference is made to one of the above standards, the revision in effect at the time of bid opening shall apply.

1.7 PROJECT/SITE REQUIREMENTS

A. The RVSS shall be capable of continuous operation in an ambient temperature range between 0°C and 40°C.

1.8 SPARE PARTS

A. Provide the following spare parts in the quantities specified:

1. One of each type printed circuit board.

2. Two power diodes.

3. One pair power transistors.

4. 50 percent replacement fuses, all types and sizes.

5. One operator interface module.

6. Two replacement LEDs for pilot lights of each color and type.

B. Spare parts shall be boxed or packaged for long term storage. Identify each item with manufacturers name, description, and part number on the exterior of the package.

1.9 MANUFACTURER'S FIELD SERVICES

A. The Manufacturer shall furnish a service representative for the equipment and materials furnished under these specifications. The service representative shall be technically competent, factory trained, experienced in the installation and operation of the equipment, and authorized by the manufacturer to perform the work stipulated.

B. Each service representative shall be a direct employee of the manufacturer of the respective item of equipment.

C. The service representative shall provide such services and assistance as is required for the proper installation, testing, and operation of each item of equipment to include but not be limited to:

1. Service considered by the manufacturer as a condition to providing the warranties and guarantees specified herein.

2. Service required to correct design and manufacturing errors.

3. Service required to aid the Contractor during installation of the equipment.

4. Equipment inspection and testing after installation and changes or adjustments required to assure proper operation.

D. Signed service reports verifying the tests and work performed, errors corrected, and the state of the equipment readiness at the time of inspection shall be submitted to the City upon completion of any service representative's visit to an erection site. The reports may be in letter form or on special forms furnished by the equipment manufacturer.

E. The bid shall include all costs of service representatives, including overtime work, to provide the services specified herein.

F. The bid shall include the following number of person-days for the services specified. Times shown are exclusive of travel time.

Person-Days	Manufacturer's Service
2	Installation assistance, field corrections.
1	Inspection, adjustments, testing and startup.
1	Certification and test reports.

PART 2 PRODUCTS

2.1 ACCEPTABLE MANUFACTURES

A. Manufactures: Subject to compliance with these specifications, the typical equipment, systems, and accessories installed shall be manufactured by:

1. Allen-Bradley, SMC-Flex

2. Eaton Corporation, S811

3. General Electric, ASTAT Plus

4. Square D, Altistart

5. Approved equal.

2.2 RATING

A. Service Conditions

1. Input power: 460 VAC, ±10 percent, 3 phase, 60 Hz.

2. The RVSS shall have a continuous output current rating equal to or greater than the motor full load nameplate current.

3. Input frequency: ±5%

4. Ambient temperature: 0 degrees C to 40 degrees C.

5. Elevation: Up to 3300 feet above mean sea level.

6. Relative humidity: Up to 90% non-condensing.

B. RVSS shall withstand five cycle transient voltage dips of up to 15 percent of rated voltage without an undervoltage trip or fault shutdown, while operating a variable torque load.

2.3 CONSTRUCTION

A. Provide separate standalone RVSS motor starters for each unit provided. Provide RVSS in NEMA 12 enclosures fully integrated in to the control scheme described for the systems specified in Sections 11502, 11600, and 13550. Provide any necessary enclosure ventilation fans or heat sinks required to maintain temperature rating of the RVSS provided.

B. The solid-state reduced-voltage starter components shall be tested and installed in accordance with UL 508C. The RVSS shall be microprocessor controlled, integrated unit with power SCRs, logic board, paralleling bypass contactor, power factor correction capacitor contactor, and electronic motor protection overload relay enclosed in a single housing.

C. The SCR-based power section shall consist of three sets of back-to-back SCRs and shall be rated for a minimum peak inverse voltage rating of 1400 volts PIV. Units using triacs or SCR/diode combinations shall not be acceptable. Provide resistor/capacitor snubber networks.

D. The logic board shall be mounted for ease of testing, service, and replacement. It shall have quick disconnect plug-in connectors for current transformer inputs, line and load voltage inputs and SCR gate firing output circuits.

E. The paralleling run bypass contactor shall energize when the motor reaches 90% of full speed and close/open under rated motor current. Bypass contactor shall utilize an intelligent coil controller to limit contact bounce and optimize coil voltage during varying system conditions.

F. The power factor correction capacitor contactor shall energize when the motor reaches 100% of full speed and de-energize when the motor Stop command is executed. Capacitor contactor shall utilize an intelligent coil controller to limit contact bounce and optimize coil voltage during varying system conditions.

G. Maximum continuous operation shall be at 115% of continuous ampere rating.

H. Auxiliary Power: Provide 120 VAC and/or 48VDC auxiliary power on RVSS terminal strips for use in powering auxiliary control devices.

2.4 PROTECTIVE FEATURES

A. Provide RVSS motor protection relay:

1. Solid state overload relay capable of either an electronic or mechanical reset after a fault. Units using bimetal overload relays are not acceptable.

2. Electronic overload protection based on inverse time-current algorithm. Overload protection shall be capable of being disabled during ramp start for long acceleration loads via digital interface module. Overload protection shall be adjusted via the device keypad and shall have a motor full load ampere adjustment from 30 to 100% of the maximum continuous ampere rating of the starter. Provide user selectable overload class setting of 5, 10, 20 or 30 via a DIP switch setting or the device keypad.

3. Protection against improper line-side phase rotation, shutting down if a line-side phase rotation other than A-B-C exists; allow feature to be disabled via the digital interface module.

4. Protection against a phase loss or unbalance condition, shutting down if a 50% current differential between any two phases is encountered; allow feature to be disabled via the digital interface module.

5. Protection against motor stall or motor jam conditions; allow feature to be disabled via the digital interface module.

6. Motor protection relay shall be integral to the RVSS enclosure, manufactured by the RVSS manufacturer Multilin, Schweitzer Engineering Laboratories, or approved equal.

B. Provide overtemperature trip protection on heat sink.

C. Provide the following short circuit and input protective features.

1. Input circuit breaker.

2. Solid state instantaneous overcurrent trip.

3. Undervoltage protection with automatic restart.

4. Ground fault protection.

D. Provide the following internal protective features.

1. Transient surge protection.

2. Overcurrent protection.

3. Current limit, inverse time type.

2.5 OPERATIONAL FEATURES

A. Digital interface module mounted on the starter enclosure door shall be used to program and control the soft starter. Display shall include digital readout, LED or similar providing equipment status and fault conditions in full text format. Monitoring parameters shall include line currents, pole currents, pole voltages, number of starts, and DC control voltage. Soft starter interface module shall at a minimum display motor status and the previous 5 fault conditions.

B. The digital keypad shall allow operators to enter exact numerical settings in English engineering units. A user menu shall be provided as a guide to parameter settings. Coded messages on keypad will not be acceptable. Parameters are to be factory set in EEPROM and resettable in the field. Parameters shall be password protected. The EEPROM stored variables shall be transferable to new and spare boards.

C. The keypad/display module shall have a key switch to control operation of the keypad. The key shall be removable in either the "Enabled" or "Disabled" positions. The keypad module shall contain a "self-test" software program that can be activated to verify proper keypad operation. The keypad display shall contain a full alphanumeric character set.

D. At a minimum, the following controls and indicators shall be provided, either separately or as part of the keypad/display:

1. POWER ON, RUN AND FAULT indication.

2. FAULT RESET control.

3. LOCAL-OFF-REMOTE control mode selector.

4. Manual START/STOP controls.

E. Provide the following control function adjustments from the digital interface module:

1. Current limit and boost.

2. Auto restart delay.

3. Selectable Torque Ramp Start or Current Limit Start.

4. Adjustable Kick Start Time: 0–2 seconds.

5. Adjustable Kick Start Torque: 0–85%.

6. Adjustable Ramp Start Time: 0.5–180 seconds.

7. Adjustable Initial Starting Ramp Torque: 0–85%.

8. Adjustable Smooth Stop Ramp Time: 0–60 seconds.

F. Accept a remote dry contact closure to start and stop the RVSS with the RVSS control in the REMOTE mode.

G. Provide additional RVSS firmware or system programming for full linear ramp-up/ramp-down controls if required for satisfactory operation of the turn-key, packaged systems specified in Section 11502, 11600, and 13550.

H. Provide the following Form C digital output contacts at a minimum unless otherwise shown on the Drawings:

1. Run

2. Fault

3. High Temp

4. In Bypass

5. Ready

2.6 COMMUNICATIONS INTERFACE

A. Provide Ethernet, Modbus TCP interface integrated in the RVSS in accordance with UL procedures and practices. Ethernet, Modbus TCP implementation requirements shall be as specified in Section 13410.

B. Each starter shall communicate via Ethernet, Modbus TCP, and monitor all available RVSS parameters and shutdown conditions per the RVSS standard interface or motor protection relay.

C. The Ethernet, Modbus TCP data communications shall be fully integrated into the unit. The Ethernet, Modbus TCP system shall be installed, configured, and tested prior to on-site installation. All Ethernet, Modbus TCP network transmission media shall be provided for a complete system, including network cable, terminations, switches, and all required network hardware.

D. Ethernet, Modbus TCP network cable shall be Category 5 or better and conforming to the requirements of UL 845. Ethernet, Modbus TCP cable shall have an insulating rating equal to at least the maximum circuit voltage applied to any conductor within the enclosure or raceway. Special separation, barriers, or internal conduit for the Ethernet, Modbus TCP conductors are not acceptable.

E. The Ethernet, Modbus TCP address shall be assigned to each unit during factory configuration. I/P addressing shall conform to City standards as specified in Section 13410.

2.7 POWER FACTOR CORRECTION CAPACITORS

A. General

1. Provide power factor correction capacitors mounted either integral to the RVSS equipment or in “top hat” enclosures located above the RVSS as shown on the Drawings.

2. Provide 480 Volt, 3 phase, Delta connected capacitors as recommended by the RVSS manufacturer for compatibility with the starter and motors as specified in 16220 and as required by the Blower System Supplier specified in 11502 and 13550 and Biosolids Dryer System Supplier specified in 11600.

3. Capacitor switching shall be coordinated with RVSS operation and contactor switching as specified herein.

4. Manufacturers:

a. Eaton Corporation

b. General Electric

c. Square D

d. Approved equal

2.8 DIAGNOSTIC CAPABILITY

A. Provide complete built-in diagnostic and test capability to enable maintenance personnel to rapidly and accurately identify the cause of equipment failure.

2.9 SURFACE PREPARATION AND SHOP COATINGS

A. All non-current carrying metal parts of the equipment cabinet shall be cleaned of all weld spatter and other foreign material and given a heat cured, phosphatized chemical pre-treatment to inhibit rust.

B. Unpainted non-current carrying parts shall receive a protective zinc plating to prevent corrosion. Printed circuit boards shall be coated with a protective conformal epoxy. All device contacts shall be silver cadmium plated.

PART 3 EXECUTION

3.1 INSTALLATION

A. Install the equipment in accordance with the manufacturer's instructions.

3.2 FACTORY QUALITY CONTROL

A. Provide manufactures standard factory test.

3.3 FIELD QUALITY CONTROL

A. The Contractor shall provide acceptance testing of the RVSS's per NETA guidelines for RVSS's and per the requirements of Section 16080.

B. Where RVSS's are part of a mechanical system package, the manufactures representative shall coordinate the acceptance test with the package supplier and the Contractor. Refer to Sections 11502, 11600, and 13550

C. Confirm proper operation of the network communications following the favorably reviewed testing procedures for testing the network interface communications including delivery of all monitored variables to preassigned registers and confirmed at the plant SCADA system per Section 13400.

3.4 ADJUSTMENT

A. Make all RVSS internal adjustments and all adjustments necessary for manual and automatic operation of the entire system of driven equipment.

3.5 CLEANING

A. Remove all rubbish and debris from inside and around the equipment. Remove dirt, dust, or concrete spatter from the interior and exterior of the equipment using brushes, vacuum cleaner, or clean, lint-free rags. Do not use compressed air.

END OF SECTION

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SECTION 16271 – PAD MOUNT LIQUID-FILLED MEDIUM-VOLTAGE TRANSFORMERS

PART 1 GENERAL

1.1 DESCRIPTION

A. Work included:

1. Fabricate transformers in accordance with applicable ANSI, NEMA, and IEEE standards, except where specific requirements of this section take precedence.

2. Transformers shall be pad-mounted, compartmental type consisting of a transformer tank, medium-voltage primary cable terminating compartment using separable, insulated medium-voltage connectors, and low-voltage secondary compartment for busduct and feeder cable entrances. Transformer tank and compartments shall be assembled as an integral unit, and designed for outdoor installation on a concrete containment pad.

1.2 RELATED WORK

A. Section 01612 – Seismic Design Criteria

B. Section 16000 – Common Work Results for Electrical

C. Section 16080 – Electrical System Analyses and Commission Field Testing

D. Section 16121 – Medium Voltage Cables

E. Section 16122 – Fiber Optic Cables and Equipment

1.3 SUBMITTALS

A. Submit in accordance with Section 01340 and 1600, product data showing and identifying manufacturer, catalog numbers, dimensions, weights, nameplate data, dielectric coolant volume, recommended concrete pad design, and accessories as specified in this Section.

B. Scaled and dimensioned assembly drawings with front, side, and section views. Drawings shall show location of all accessories and conduit stub-up areas.

C. Connection diagrams for power cables, alarms, and monitoring sensors.

D. Transformer diagrammatic nameplate.

E. Recommended transformer primary fuse requirements including fuse type, fuse rating, and transformer through-fault damage curves for both three-phase and secondary single-phase-to-ground conditions. Where required, provide protection let through documentation from the listing authority.

F. Equipment seismic qualifications, seismic calculations, and anchorage details as specified in Section 01612.

G. Cooling liquid containment calculations verifying that the containment volume shown on the Drawings is adequate to fully contain a leakage of the fluid. If additional containment volume is required, include modifications to the containment structure required to provide the necessary containment. All costs associated with any necessary modifications to the containment area shall be provided at no extra cost to the Owner,

H. Manufacturer's installation instructions.

I. Certified factory and field test reports

J. Dimensioned as-built documents and O&M manuals.

K. Training schedule.

1.4 REFERENCES

A. American National Standards Institute (ANSI)/Institute of Electrical and Electronic Engineers (IEEE):

1. ANSI C57.12.22 – Transformers - Pad-Mounted, Compartmental-Type, Self-Cooled, Three-Phase Distribution Transformers with High-Voltage Bushings, 2,500 kVA and Smaller: High Voltage, 34,500 Grd Y/19 920 Volts and Below; Low Voltage, 480 Volts and Below Requirements.

2. ANSI C57.12.70 – Terminals Markings and Connections for Distribution and Power Transformers.

3. ANSI/IEEE C57.12.00 – Distribution, Power, and Regulating Transformers, General Requirements for Liquid-Immersed.

4. ANSI/IEEE C57.12.80 – Terminology for Power and Distribution Transformers.

5. ANSI/IEEE C57.12.90 – Test Code for Liquid-Immersed Distribution, Power and Regulating Transformers and Guide for Short Circuit Testing of Distribution and Power Transformers.

6. ANSI/IEEE C57.109 – Guide for Liquid - Immersed Transformer Through - Fault - Current Duration.

7. ANSI/IEEE C89.1 – Audible Sound Level Test.

B. National Electrical Manufacturers Association

1. NEMA TR-1 – Transformers, Regulators, and Reactors

C. National Fire Protection Association

1. NFPA 70 – National Electrical Code

D. Factory Mutual Research Corporation (FMRC)

1. FMRC 3990 – Less of Non-Flammable Liquid Insulated Transformers

1.5 QUALITY ASSURANCE

A. Qualifications

1. The equipment furnished under this Section shall be the product of a manufacturer who has produced Padmounted Transformers of equal or greater kVA capacity and equal or higher voltage for a period of at least 15 consecutive years.

2. Transformer(s) shall be designed, assembled and tested by the manufacturer of the core and coil assemblies used in the transformer.

3. Transformers and fill liquid shall be UL or FM listed and labeled as a Less-Flammable Liquid Filled Transformer and in compliance with the NEC Sections 100-3 and 450-23. Provide all required protective devices, sensors, construction components, nameplates, for achieving the indicated listing and labeling.

1.6 MANUFACTURE'S FIELD SERVICES

A. The transformer manufacturer shall provide the field services of a factory technician as necessary to supervise/inspect installation, test and start-up all equipment provided as part of the Contract. The work shall include all travel and living expenses in addition to the technician's time required to complete supervision of the installation, testing, start-up, and training as specified herein. All equipment required for testing, start-up, performance verification, and training shall be provided by the manufacturer's technician.

B. At a minimum the manufacture shall provide the following technician person-days for each occurrence. However, the Contractor shall provide all necessary manufacturer's field support for a complete installation, fully tested, and operational as required for a fully functioning system and as specified in Sections 01756. 16000, and 16080 under the Contract Bid Price. The minimum durations listed below do not preclude additional time that may be required to achieve all the requirements of the Contract Documents.

Description	Person-Days
Inspection	1
Installation Assist	2
Settings, Adjustments	1
Start Up and Testing	1
Training	1

C. Training

1. Shall be by manufacturer's qualified representative and shall include instruction on service, operation, and maintenance of the transformer, as recommended by the manufacturer.

2. Training sessions shall consist of two (2) , four (4) hour sessions. Sessions shall be identical and coordinated with the Engineer to correspond with City staffing and shift requirements.

PART 2 PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

A. Manufactures: Subject to compliance with these specifications, the typical equipment, systems and accessories installed shall be manufactured by:

1. General Electric Company.

2. ABB.

3. Cooper Power Systems.

4. Approved Equal.

2.2 RATING

A. Transformer: 3-phase, 60 hertz, and designed in accordance with the following:

1. Coolant: UL classified, less flammable high fire point (300 degrees Celsius), non-toxic, and biodegradable. Coolant shall be Cooper FR3; Beta Fluids; ABB BioTemp Fluid; or equal.

2. Temperature Rise: dual rated, 55/65 degrees Celsius. The average winding temperature rise above ambient temperature, when tested at the base transformer rating, shall not exceed 55°C, and when tested at 112% of the base rating, shall not exceed 65°C.

3. Type: Self-cooled.

4. Capacity Rating: Provide as shown on the Drawing for each unit

5. Primary:

   a. 21kV delta (nominal)

6. Secondary:

   a. 480Y/277V

7. Provide rated kVA taps for two 2-1/2 percent steps above and 2-1/2 percent steps below rated nominal voltage.

8. Provide over current fuse protection limiting the I2t let-through during a fault condition as required by the listing and labeling authority. Transformer overcurrent protection shall be integral to the transformer enclosure.

9. Nominal Impedance: 5.75 percent.

10. Basic Impulse Insulation Level (BIL):

    a. Primary: 150 kV

    b. Secondary: 30 kV.

11. Sound Level: 63 dB (maximum average)

2.3 FABRICATION

A. Construction: Sealed tank construction with welded cover. Dead front type. Permanently locate an inorganic gasket between the cover and the tank flange during the welding of the transformer cover to prevent the entrance of weld spatter into the tank.

B. Terminal Compartments:

1. Locate side-by-side, separated by a steel barrier, full height, air filled, and incoming and outgoing terminal compartments with hinged doors.

2. The incoming compartment shall be accessible only after the outgoing compartment has been opened. Incoming compartment shall enclose the transformer primary bushings.

3. Compartment hood shall be removable for pulling cables and making connections. Compartment door sills shall be removable to permit rolling or skidding unit into place over conduit stub-ups.

4. Provide incoming and outgoing bushings to accept the quantity and size of conductors indicated on the Drawings.

a. Transformer primary connections shall be as follows for cable sizes shown on the drawings:

1) Medium-voltage bushings shall be provided for a radial feed configuration using a modular connection system complying with IEEE 386, for use on 25kV class EPR solid dielectric cable.

b. Secondary terminations shall be tin-plated spade-type bushings. Quantity of connection holes and configuration shall conform to the requirements for connection to busduct as shown on the Drawings.

5. Primary and secondary winding material (coils) shall be made of copper.

6. Primary cable accessory parking stands shall be provided and shall be located such that the separable insulated connectors can be operated by hot-line tools.

7. Provide a bolted tamper-resistant handhole in the tank cover for access to internal connections. Handhole shall be 8-inch diameter (minimum).

8. Compartment Doors:

a. Hinged to latch in open position. Incoming compartment door shall have a fastening device that is accessible only through the outgoing compartment.

b. Both compartment doors shall be able to be locked with a single padlock.

c. Hinge assemblies shall be made of 316 stainless steel.

9. Standard ANSI green finish color.

2.4 ACCESSORIES

A. Provide the following standard features and accessories:

1. Top filter press connection with pipe cap, 1/2 inch minimum.

2. Drain and filter press valve, 1/2 inch minimum, globe-type, sampling valve.

3. The transformers shall have de-energized hand-operated tap changing equipment in the primary winding with a range of plus or minus 5 percent in 2-1/2-percent steps, of the middle tap of high voltage. All voltage taps shall have full transformer kVA rating. The tap changer shall have position indication. The tap changer shall have external operating mechanism with provisions for padlocking.

4. Diagrammatic nameplate on both the inside and outside surfaces of the outgoing compartment door. Inside nameplate shall be readable with cables in place.

5. Liquid-level gauge with adjustable level switch with Form C contacts for remote monitoring.

6. Top liquid thermometer, dial-type, 0-120 degrees Celsius scale. Provide adjustable high temperature switch with Form C contact for remote monitoring

7. Adjustable sudden high pressure alarm switch with Form C contacts for remote monitoring.

8. Pressure vacuum gauge, -10 psig to +10 psig scale.

9. Copper-faced ground pads for number of connections as shown on the drawings.

10. Handhole in cover.

11. Lifting lugs at each corner of tank for lifting the complete transformer.

12. Jacking facilities at each corner of base for jacking the complete transformer.

13. Quality control pressure relief valve mounted in low-voltage compartment with automatic resealing-resetting operation and mechanical indicator which identifies device operation.

14. Sudden pressure relay with seal-in contact located at switchgear.

2.5 LABELING

A. A plastic laminated copy of the as-built main plant distribution single-line diagram, certified test results, baseline dissolved gas and metals analyses, and instruction manual shall be provided in the inside of the low-voltage compartment door.

B. Provide a second nameplate with the UL or FM approval indication with information as required by the particular approval agency.

2.6 FACTORY QUALITY CONTROL

A. The Contractor shall provide a 10-working-day advance notice of factory testing. City reserves the right to witness all testing for the unit substation equipment.

B. Prior to shipment, the Contractor shall test and inspect the unit substations. The tests shall verify physical configuration of assembly and workmanship, the mechanical adjustments of parts and components, and the sequencing and functional operations of the power circuit breaker control systems.

C. Shop Testing: Transformer shall receive routine tests in accordance with Table 17 of ANSI/IEEE C57.12.00/C57.12.90 in addition to other specific tests noted in this Section for the unit to be supplied. Certified test form shall contain the following testing result summary:

1. Transformer ID as shown on the Drawings, manufacturer product number, serial number, and test date.

2. Phase, frequency, and coolant type.

3. High and low voltage winding type, voltage rating, and BIL.

4. Voltage values for each of the five primary tap settings.

5. Regulation at 100%, 90%, 85%, 80%, and 75% PF.

6. Efficiency at 125%, 100%, 75%, 50%, and 25% load.

7. Insulation power factor (%), capacitance, and insulation resistance.

8. Applied voltage test.

9. Induced voltage test.

10. Routine impulse test.

11. Polarity and phase relation check on the rated voltage connection.

12. Ratio check at all tap settings.

13. No-load loss and exciting current at rated voltage.

14. Impedance voltage and load loss at rated current and frequency on the rated voltage connection.

15. Resistance measurements of all windings on the rated voltage tap.

16. Liquid testing – PF and dielectric breakdown voltage.

17. Mechanical leak test: prior to shipment, liquid-fill and pressure-test transformer for at least 8 hours at the maximum operating pressure for detecting the presence of leaks.

D. Verification of Performance: Submit test results certified by a registered professional engineer.

PART 3 EXECUTION

3.1 INSTALLATION

A. Install on concrete pad following manufacturer's instructions and layout from approved shop drawings.

B. Provide equipment anchorage to resist seismic forces as directed by the approved seismic calculations per Section 01612.

C. Manufacturer or manufacturer's representative shall inspect the equipment before start-up and certify that system has been correctly installed and prepared for start-up as specified in this section and in Section 16000.

3.2 FIELD QUALITY CONTROL

A. Testing and Inspection: As specified in Section 16080.

B. Provide baseline dissolved gas and metals analysis measurements.

C. Provide baseline thermographic analysis.

D. Following installation, test operation and demonstrate that all components protective devices, interlock devices, and control devices function properly.

E. Adjust primary taps so that secondary voltage is within 2 percent of rated voltage.

3.3 CLEANING

A. Remove all rubbish and debris from inside and around the equipment. Remove dirt, dust, or concrete spatter from the interior and exterior of the equipment using brushes, vacuum cleaner, or clean, lint-free rags. Do not use compressed air.

B. Apply touch-up paint so that all equipment is free from gouges, scratches, or other finish blemishes that occurred during shipping or installation.

3.4 TRAINING

A. Provide the services of a factory trained field engineer for training at the Project site in accordance with Section 01758. Training shall include instructions on adjusting, servicing and maintaining the transformer. The field engineer shall be at the site as specified in these Specifications.

END OF SECTION

SECTION 16290 – ELECTRICAL POWER MONITORING SYSTEM

PART 1 GENERAL

1.1 DESCRIPTION

A. Work included

1. Furnish and install electrical power monitoring equipment as shown on the drawings and as specified herein.

2. Provide configuration and test power monitoring equipment.

3. Test power monitor network communications.

B. Related sections

1. Section 16000 – Common Work Results for Electrical

2. Section 16080 – Electrical System Analyses and Commission Field Testing

3. Section 16350 – Medium Voltage Switchgear

4. Section 16436 – 480V Switchgear

5. Section 16442 – Motor Control Centers

1.2 QUALITY ASSURANCE

A. Coordinate with the suppliers of the electrical distribution equipment to ensure sufficient space is available for mounting current transformers, voltage transformers, control power transformers, and the power monitoring equipment. The power monitoring equipment manufacturer shall be responsible for verifying that all space, NEMA, and UL requirements are met when mounted within the equipment enclosures.

B. The power monitors shall be manufactured in an ISO9001 registered factory.

1.3 SUBMITTALS

A. Submittals shall be made in accordance with Section 01340 and Section 16000.

B. The Contractor shall furnish submittals for approval as outlined below.

1. Product data sheets.

2. Product outline and dimensional drawings showing device layout, interconnection points and mounting requirements.

3. Submit wiring, interconnection, and mounting diagrams for the power monitor for each switchgear, switchboard, or motor control center where the power monitor is to be installed. Submit detailed drawings including wire numbers and terminals for each installation. Standard or generic diagrams will not be acceptable.

4. Network Communications Interface.

   a. Submit network module data sheets and memory mapping for devices resident within the assembly network. Submit device parameter list with all data variables available for remote monitoring over the network interface. List shall include variable internal name, descriptive field that fully describes the contents and use of the variable, memory address and bit size, variable type (analog, discrete, text), engineering units, and function (e.g., status, alarm, internal diagnostic, etc.). Include complete configuration instructions including addressing, register allocation, data mapping, and options.

   b. Network access requirements including method for accessing equipment variables, software features, and physical hardware interface details.

5. Submit complete details of trending, waveform capture, harmonic analysis, and power analysis software. Submit license agreements indicating all software has been licensed to the City.

1.4 REFERENCES

A. American National Standards Institute (ANSI)/ Institute of Electrical and Electronics Engineers (IEEE)

   1. ANSI/IEEE C37.90.1 – IEEE Standard Surge Withstand Capability (SWC) Tests for Relays and Relay Systems Associated with Electric Power Apparatus.

B. American National Standards Institute (ANSI)/National Electrical Manufacturers Association (NEMA)

   1. ANSI/NEMA C12.20 – Electricity Meters 0.2 and 0.5 Accuracy Class.

   2. ANSI/NEMA C12.1 – Electricity Meters 0.1 Accuracy Class.

   3. ANSI C39.1 – Electrical Analog Indicating Instruments Requirements

1.5 MANUFACTURER'S FIELD SERVICES

A. Training

   1. Training shall be by the manufacturer's qualified representative and shall include instruction on complete service, operation, and maintenance of the power monitoring equipment and software as recommended by the manufacturer.

PART 2 PRODUCTS

2.1 POWER MONITOR

A. Provide a UL listed and true RMS digital multifunction power monitor.

B. Microprocessor based and fully user programmable.

C. Accept input from standard instrument transformers (5A secondary current transformers and 120V secondary potential transformers).

D. The monitor shall accept a voltage monitoring range of up to 600 volts, phase-to-phase.

E. The monitor shall withstand 200% rated current continuously. It shall withstand 10X rated current for at least 3 seconds. Surge withstand shall conform to IEEE C37.90.1

F. Provide multifunction digital display for of all variables in standard engineering units, (voltage in volts, current in amperes, power in kilowatts, etc.)

G. Power monitor shall be able to perform event logging

H. Display and monitoring transducer shall be factory-integrated into the motor control center, switchboard, or switchgear lineup.

I. At a minimum the power monitor shall be able to measure the following true RMS real-time parameters:

1. Phase Voltage
2. Phase Current
3. Real Power
4. Reactive power
5. Apparent Power
6. Power Factor
7. ± Watt Hour
8. ±VAR Hour
9. Frequency
10. Voltage angle
11. Current Angle
12. Total harmonic distortion in percentage, minimum 31st order
13. K-factor

J. Provide unit capable of capturing and reporting harmonic data via a graphic image of the waveform and making it available for download through an integral digital communication port.

K. Rated for use at temperature from -20 degrees C to +70 degrees C.

L. User programmable for any current and voltage transformer ratios. If software is necessary to perform configuration of the monitor, provide configuration software as well as the necessary cables and connectors. Any software provided shall be licensed to the City of Brentwood

M. Interfaces

1. Minimum of two programmable Form C (NO/NC) output contacts for remote monitoring.

2. Minimum of four programmable analog outputs, 0-1mA or 4-20mA.

3. Each monitor shall communicate via Ethernet, Modbus TCP, with all available parameters available and addressed on the Ethernet link. The Ethernet, Modbus TCP data communications shall be integrated into the unit. The Ethernet, Modbus TCP system shall be installed, configured, and tested prior to on-site installation. All Ethernet, Modbus TCP network transmission media shall be provided for a complete system, including network cable, terminations, switches, and all required network hardware.

N. Provide 0.5% class accuracy ANSI C12.

O. Sample rate shall be a minimum of 64 samples per cycle.

P. Acceptable manufacturers:

1. Eaton Corporation IQData model with options and features as specified

2. ABB/General Electric, Multilin model with options and features as specified

3. Schneider Electric/Square D, ION model with options and features as specified

4. Approved equal.

PART 3 EXECUTION

3.1 INSTALLATION

A. Power monitoring equipment shall be incorporated into the power distribution equipment as shown on the drawings and specified herein. Provide all mounting hardware, CTs, VTs, control power transformers, and installation details including grounding requirements to ensure that the power monitoring equipment are installed in conformance with the manufacturer and the supplier of the equipment.

B. Power monitoring equipment installation within the equipment shall not violate the manufacturer's warranty for the power monitor or the respective equipment.

3.2 FIELD QUALITY CONTROL

A. Field tests and inspections shall be as specified in Section 16080.

B. Confirm proper operation of the network communications following the favorably reviewed testing procedures for testing the network interface communications including delivery of all monitored variables to preassigned registers and confirmed at the plant SCADA system per Section 13400.

END OF SECTION

SECTION 16350 – MEDIUM VOLTAGE SWITCHGEAR

PART 1 GENERAL

1.1 SCOPE OF WORK

A. Furnish and install the metal-clad type Switchgear in outdoor rated walk-in enclosure as shown on the Drawings and as specified herein. The Switchgear shall include a metering section per PG&E requirements and meet PG&E requirements for 22 kV Primary Service equipment.

B. Coordinate switchgear startup and commissioning with project testing, analyses, and protective relaying coordination study performed under Section 16080.

1.2 RELATED SECTIONS:

A. Section 01612 – Seismic Design Criteria

B. Section 01614 – Wind Design Criteria

C. Section 16000 – Common Work Results for Electrical

D. Section 16075 – Electrical Identification

E. Section 16080 – Electrical Analyses and Commission Field Testing

F. Section 16244 – Station Battery System

G. Section 16290 – Electrical Power Monitoring

1.3 SUBMITTALS

A. Submit in accordance with Section 01340 and Section 16000, shop drawings and product data.

B. Submittals shall be organized with each section separated by indexed tabs with a table of contents clearly identifying the content of each tab designated section.

C. All submittal drawings shall be prepared on 11x17 drawing format using electronic CADD systems and printed on the supplier's title block. Each drawing shall be individually and uniquely numbered to facilitate drawing identification.

D. Equipment Submittal

1. Equipment shop drawings showing elevation and plan views, nameplate data, bus arrangement, dimensions, weight, shipping splits, and metering layouts for new switchgear. Indicate all options, special features, ratings, and deviations from this Section.

2. Conduit stub-up plans, equipment layout plans, and details for new switchgear footprint and mounting. Plans shall be on a minimum size of 11" x 17" drawings. Coordinate layout plan with conduit entrance and stub up requirements as shown on the Drawings.

3. Physical sizing layouts for all switchgear installed layouts. Submit layouts for external face and internal component layout confirming adequate physical space and equipment orientation. Layouts shall be drawn to scale with all required devices included and indicate all new cutouts with necessary gasketing and other ancillary equipment necessary for a complete installation. Layouts shall show all auxiliary equipment space requirements including batteries, chargers, panelboards, telephone backboards, lighting, convenience receptacles, etc.

4. Nameplate schedule for internal and front panel mounted components.

5. Itemized bill of materials for metering, accessories and control equipment.

6. Product data sheets and catalog numbers for circuit breakers, metering, protective relays, current transformers, potential transformers, control power transformers, panelboards, batteries, and auxiliary equipment specified. Clearly indicate or list those options, features, ratings, and accessories furnished specifically for this project.

7. Where Modbus relay devices are specified herein, submit details of the Modbus interface, any required software drivers, interface programming instructions, and complete Modbus memory maps for each relay indicating address and content of all available monitored variables.

8. Where electronically configured relays are provided, submit details of the electronic configuration process including method for configuration, details of any device programming software, and software licensing assigned to the City.

9. Phase and ground fault time-current characteristics for all protective and control relays.

10. Submit 24 VDC power supply distribution schematic for auxiliary loads.

11. Submit arc flash detection fiber optic link optical budget calculations. Calculations shall account for all fiber, terminations, and other losses and confirm that the overall optical link budget is sufficient for acceptable operation of the fiber detection circuits per the sensor and relay manufacturer's requirements.

12. Details of the relay and controller programming and configuration application packages to be used. Indicate all standard and optional features provided. Include copies of license agreements indicating assignment of licenses to the City.

13. Technical details for performing the overcurrent, arc flash detection, differential current, or other protection algorithms specified herein or as required by PG&E. Identify all necessary hardware and software requirements. Submit details of each hardware component required for the protection implementation, supporting relay logic in narrative and relay programming language, interface to HMI graphics, and timing diagrams for relay and circuit breaker operation in sufficient detail to verify speed of the resulting breaker fault clearing time.

14. Submit details of the HMI application packages to be used. Indicate all standard and optional features provided. Include copies of license agreements indicating assignment of licenses to the City.

15. Complete system Input/Output (I/O) list. Points anticipated to be subject to field or process specific adjustments shall be identified with initial or default settings to be used for initial system development purposes. Both hard I/O and network derived I/O shall be included. The I/O list shall be sorted in order by:

    a. Physical location: Panel, rack, slot, component as applicable.

    b. Source interface: Hardwired I/O or virtual (network derived).

    c. I/O Type: AI, AO, DI, DO etc.

    e. I/O point unique identification, device, or loop tag.

    f. Source device unique identification, device, or loop tag.

16. Complete block diagram showing the inter-connections between major hardware components, media type between components, raceway requirements (conduit, wireway, etc.), raceway identification, network protocol used at each network level, and all hardware components showing the interconnection of all field devices, switchgear device terminals, and ROP device terminals.

17. Device DC current requirements for coordination with station battery sizing calculations required under Section 16240:

    a. The trip, close, and charging motor for the circuit breaker.

    b. Protective relays

    c. Network and communication equipment

    d. HMI

    e. Controllers

    f. All other DC-powered switchgear equipment.

E. Panel Submittal: Panel assembly and elevation drawings shall be drawn to scale and detail all equipment in or on the panel. As a minimum, the panel drawings shall include the following:

1. Submit evidence that all control panels shall be constructed in conformance with UL 508 and bear the UL seal confirming the construction. Specify if UL compliance and seal application shall be accomplished at the fabrication location or by field inspection by UL inspectors. All costs associated with obtaining the UL seal and any inspections shall be borne by the Contractor and included in the Project Bid Price.

2. Catalog cuts and descriptive literature for all Human Machine Interfaces (HMI), controllers, input modules, output modules, modems or communication interfaces, network interface modules, mounting racks, and power supplies. Submit system bill of materials and descriptive literature for each hardware component that fully describes the units being provided.

3. Interior and exterior panel elevation drawings to scale.

4. Panel total weight including all components.

5. Nameplate schedule.

6. Conduit access locations for top or bottom entry. Conduit identifiers shall be shown referenced to the conduit tag number shown on the Electrical Drawings.

7. Panel construction details.

8. Cabinet assembly and layout drawings to scale. The assembly drawing shall include a comprehensive bill of material on the drawing with each panel component clearly defined. The bill of material shall be cross-referenced to the assembly drawing to readily identify any component of the assembly by manufacturer and model number.

9. Show relative physical arrangement and terminal locations of devices and terminal blocks.

10. Internal schematics, wiring diagrams, and point-to-point system interconnection diagrams.

    a. Typical drawings are not acceptable. Assign wire numbers on each diagram so each segment of the circuit can be identified on internal and interconnection wiring diagrams.

    b. Complete logical development of protective relaying strategy and control schematic based hard logic wiring where applicable. Any hard logic development shall be cross referenced in the programming logic development submittal.

    c. Interconnecting cross wiring for external circuit terminations wiring diagrams with numbered terminal point designations. Include termination points for auxiliary AC powered circuits, DC control power supply circuits, and remote status and alarm circuits.

    e. Show contact developments of control and selector switches, protective relays, test switches, DC and AC auxiliary relays, and similar.

    f. Use a terminal address system at origins and destinations of actual wiring. Tabular format wiring lists are not acceptable.

    g. Wire numbers assigned on schematic diagrams shall exactly correspond to wire numbers on wiring diagrams.

11. Relay protective logic software programming with proposed code with abundant comments and explanatory text to provide a full understanding by the reviewer of the logical functions implemented. Software development shall be cross referenced in the hardwired control schematic logic development submittal.

12. Submit Ethernet Modbus TCP memory map of all relay variables mapped to the Modbus TCP data structures.

F. Functional Submittal

1. Submit after released for fabrication but prior to factory testing or shipping to the site.

2. Current transformer loading and saturation calculations confirming device sizing using the devices proposed for use by the Contractor. Coordinate calculations with ground fault sensing current transformer and differential protection schemes as specified herein.

3. Complete three line and comprehensive metering and relay diagrams showing detailed power connection scheme; DC tripping circuits; control logic; interlock logic; location of test switches on current sensing, voltage sensing, device input/output status and control circuits; and protective relay logic.

4. Internal point-to-point compartment wiring diagrams for metering, relay, power distribution, and control circuits. Show all conductor and terminal numbers.

5. External circuit terminations wiring diagrams with numbered terminal point designations. Include termination points for auxiliary AC powered circuits, DC control power supply circuits, and remote status and alarm circuits.

6. Network Communications Interface.

   a. Submit network module data sheets and memory mapping for devices resident within the assembly network. Submit device parameter list with all data variables available for remote monitoring over the network interface. List shall include variable internal name, descriptive field that fully describes the contents and use of the variable, memory address and bit size, variable type (analog, discrete, text), engineering units, and function (e.g., status, alarm, internal diagnostic, etc.). Include complete configuration instructions including addressing, register allocation, data mapping, and options.

   b. Network access requirements including method for accessing equipment variables, software features, and physical hardware interface details.

G. Testing Submittals

1. Submit factory tests, field tests and inspection procedures and results.

2. Procedures shall include test description, forms, and checklists to be used to control and document the required tests. Include forms for each testing phase or process with sign-off areas for the Contractor and Construction Manager. Include punch list documentation forms for documenting issues found and the correction of those issues as part of the test submittal.

3. Submit network communications factory testing procedures including procedures for testing Modbus TCP interface communications. Procedures shall include method for 100% testing of all variables associated with each device. Procedure shall include factory test forms with sign-off sheets indicating proper transmittal and receipt of each variable, properly scaled, and addressed in conformance with the manufacturer's standard documentation. Include verification of each device Modbus TCP address conforming to City standards.

4. Upon completion of each required test, document the test by submitting a copy of the signed off and completed test procedures. Testing shall not be considered complete until the signed-off test procedures have been submitted and favorably reviewed. Submittal of other test documentation including “highlighted” wiring diagrams with field technician notes are not acceptable substitutions for the formal test documentation.

H. Training Plan: Submit a comprehensive training plan for the switchgear conforming to the requirements of the system training specified herein. The training plan shall include:

1. Definition of each course.

2. Detailed lesson plans.

3. Specific course intended audience.

4. Training class schedules including proposed dates, duration, and locations of each class.

5. Resumes of the training instructors who will implement the training plan.

I. Operations and Maintenance: Submit in accordance with 01730 and as specified herein:

1. Instruction and renewal parts books for circuit breakers, for each type of relay provided, and for all other major switchgear components.

2. Itemized list of spare parts furnished specifically for this project, including quantities, descriptions, and part numbers. Include the name, address, and phone number of the local parts distributor for the equipment.

3. The name, address, and phone number of the local sales representative and technical assistance for the equipment.

J. Seismic Requirements:

1. Submit evidence that the switchgear construction has been designed and constructed to withstand the specified seismic requirements listed in Section 01612.

2. Submit seismic anchoring calculations per Section 01612.

K. Wind Loading Requirements:

1. Submit wind loading anchoring calculations per Section 01614.

L. Submit shop drawings for the following items to the power company for approval of the primary service equipment in conformance with Section 16000. Note that the power company advises that the utility internal review period may require up to six months. Submittals to the utility shall only be made following favorable review of the equipment submittals by the Engineer.

1. Metering instrument and installation details.

2. Breaker data as applicable

   a. Medium Voltage Main Breaker single line diagram.

   b. Complete metering and relay diagrams.

   c. Three-line diagrams of protective devices.

   d. Control diagrams including DC tripping circuit.

   e. Protective relay or fuse specifications and settings.

   f. Relay submittal data including complete installation and instruction manuals.

   g. Fault and coordination study stamped by a registered California Electrical Engineer including full size phase and ground coordination curves showing full coordination with PG&E's system. Refer to requirements of Section 16080.

   h. Completed PG&E DG-5 Form incorporating settings from the approved coordination study.

   i. Field testing reports (refer also to Section 16080)

M. All other documentation required by the serving utility for primary service and cogeneration interconnection applications.

1.4 REFERENCE STANDARDS

A. Switchgear and components shall be designed, built and tested in accordance with the latest revision of the following standards:

1. ANSI C37.04 – AC Power Circuit Breaker Rating Structure

2. ANSI C37.06 – AC High Voltage Circuit Breakers Rated on a Symmetrical Current Basis - Preferred Ratings of Power Circuit Breakers

3. ANSI/IEEE C37.09 – Test Procedure for Power Circuit Breakers

4. ANSI C37.010 – Application Guide for Power Circuit Breakers

5. ANSI C37.11 – Electrical Control for AC High Voltage Circuit Breakers Rated on a Symmetrical Current Basis

6. ANSI/IEEE C37.20.2 – Standard for Metal-Clad and Station-Type Cubicle Switchgear

7. ANSI C37.90 – Relay and Relay Systems Associated with Electrical Power Apparatus

8. ANSI C57.13 – Instrument Transformers

9. ANSI/IEEE C62.11 – Standard for Metal-Oxide Surge Arresters for AC Power Systems

10. Pacific Gas & Electric Company (PG&E)

    a. Electric and Gas Service Requirements (Green Book)

    b. Utility Operations – Bulletin Number 2004PGM-11

    c. Interconnection Handbook

    d. Rule 21 – Generating Facility Interconnections

B. Where reference is made to one of the above standards, the revision in effect at the time of bid opening shall apply.

1.5 QUALITY ASSURANCE

A. The equipment furnished under this Section shall be the product of a manufacturer who has produced this same type of equipment for a period of at least 10 consecutive years.

B. Switchgear shall be designed, assembled and tested by the manufacturer of the circuit breakers used in the switchgear; or the switchgear shall be designed, assembled and tested by a switchgear integrator with the integration process certified in writing by the manufacturer of the circuit breakers used in the switchgear. The written certification shall be on corporate letterhead of the circuit breaker manufacturer; confirm that the integrator followed the circuit breaker manufacturer's specific fabrication, quality control, and testing standards; and that the manufacturer's warranty shall be in effect for all equipment installed within the switchgear by the system integrator.

C. Where reference in this specification is made to "manufacturer" it shall be understood to refer to either the manufacturer or a system integrator as applicable.

D. The switchgear equipment shall be listed or labeled by Underwriters Laboratories or other equivalent, nationally recognized independent testing laboratory for the class of service intended. A nationally recognized testing laboratory is defined as one which is approved in accordance with OSHA regulations, by the United States Secretary of Labor. Provide certification of listed equipment.

E. Acceptable Manufactures or Integrators: ABB/General Electric; Eaton Corporation; Tesco Controls; Industrial Electrical Manufacturing (IEM); Meyers Power Products, Inc; Powercon Engineering; Schneider/Square D; Siemens; or equal.

1.6 MANUFACTURER'S FIELD SERVICES

A. The switchgear manufacturer shall provide the field services of a factory trained technician as necessary to supervise/inspect installation, test, commission, and start-up all equipment provided as part of the Contract. The work shall include all travel and living expenses in addition to the technician's time required to complete supervision of the installation, testing, start-up, and training as specified herein. All equipment required for testing, start-up, performance verification, and training shall be provided by the manufacturer's technician.

B. At a minimum the manufacture shall provide the following technician person-days for each occurrence. However, the Contractor shall provide all necessary manufacturer's field support for a complete installation, fully tested, and operational as required for a fully functioning system and as specified in Sections 16000 and 16080 under the Contract Bid Price. The minimum durations listed below do not preclude additional time that may be required to achieve all the requirements of the Contract Documents.

Description	Person-Days
Inspection	1
Installation Assist	2
Settings, Adjustments	1
Start Up and Testing	5
Training	2

C. Training

1. Shall be by manufacturer's qualified representative and shall include instruction on service, operation, and maintenance as recommended by the manufacturer. Provide specific training that addresses the elements of the switchgear provided including switchgear, protective relaying, monitoring sensors, software interfaces and configuration, data monitoring, and other characteristics of the equipment provided under this Section.

2. Training sessions shall consist of two (2), four (4) hour sessions covering both operational (one session) and maintenance, diagnostics, and troubleshooting (one session) each repeated twice. Sessions shall be coordinated with the Construction Manager to correspond with City staffing and shift requirements.

3. Perform two, identical four-hour sessions of follow-up training approximately 3-months following substantial completion per the requirements of Section 01660. Coordinate follow-up training date, time, staff attendance, and topics with the Construction Manager a minimum of two weeks prior to the follow-up training session.

D. Submit a manufacturer's certificate of proper installation upon successful completion of the field testing and startup effort.

1.7 SHIPPING

A. The switchgear manufacturer shall protect and adequately pack equipment for the environmental conditions during transit to the jobsite.

B. All interconnection cables between shipping splits shall be labeled, disconnected, coiled up, and protected for transit. Dedicated shipping splits terminal blocks labeled to match the wire tags shall be furnished.

C. Sensitive components removed from cabinets shall be clearly marked for easy reassembly at the jobsite.

D. A copy of the latest revision of the bill of material shall be shipped with the equipment.

1.8 SPARE PARTS AND ACCESSORIES

A. Furnish the following maintenance accessories for the switchgear.

1. Manual spring charging crank for manually closing circuit breakers.

2. One levering crank for moving the circuit breaker between test and connected positions.

3. One breaker lifting yoke used for attachment to breaker for lifting breaker on or off compartment rails.

4. Portable lifting device for lifting breaker on or off the rails.

5. Secondary couplers for operating a power circuit breaker in the disconnected position.

6. Special wrenches or tools where required for manufacturer's recommended routine maintenance.

B. Provide the following spare parts in the quantities specified:

1. One dozen each of cover bolts, cage nuts and door fasteners.

2. One quart of touch-up paint.

3. 100 percent replacement of lens caps.

4. Six pilot lamps of each size and voltage.

5. Six control power fuses of each size.

6. One each of any network interface modules.

C. Spare parts shall be boxed or packaged for long term storage and clearly identified on the exterior of the package. Identify each item with manufacturer's name, description, part number. Deliver all parts to the Construction Manager.

1.9 FINAL SYSTEM DOCUMENTATION

A. Submit operation and maintenance manuals covering instruction and maintenance on each type of equipment in accordance with the Section 01730.

B. The instruction manuals shall be bound in three-ring binders with drawings reduced or folded for inclusion and shall provide at least the following as a minimum.

1. A comprehensive index.

2. A complete "As Built/As-Left" set of the approved hardware, settings, schematics, software, and panel fabrication shop drawings.

3. A complete list and data sheets of the equipment supplied, including serial numbers, ranges and pertinent data.

4. Full specifications sheets on each item.

5. Detailed service, maintenance and operation instructions for each item supplied.

6. Clearly defined special maintenance requirements particular to these systems along with special calibration and test procedures.

7. A written functional description of the entire system, with suitable cross-references to the systems schematic drawings and instructions.

8. Complete parts lists with stock numbers and name, address and telephone number of the local supplier.

C. Final documentation shall be new documentation written specifically for this project but may include standard and modified standard documentation. Modifications to existing hardware or software manuals shall be made on the respective pages or inserted adjacent to the modified pages. All standard documentation furnished shall have all portions that apply clearly indicated. All portions that do not apply shall be lined out.

D. The manuals shall contain all illustrations, detailed drawings, wiring diagrams and instructions necessary for installing, operating and maintaining the equipment. The illustrated parts shall be numbered for identification. All information contained therein shall apply specifically to the equipment furnished and shall only include instructions that are applicable. All such figures shall be formatted within the printing of the page to form a legible, durable, and permanent reference book.

E. All software provided under this Contract shall be licensed to the City. Submit license agreement information including serial numbers, license agreements, User Registration Numbers, etc. Submit original software diskettes, CD-ROMs, or data packs of all software provided under this Contract. Submit original paper based or electronic documentation of all software provided.

F. Machine Readable Documentation - Provide two sets of as-built documentation on CD-ROMs in machine readable format for all programs developed under this Contract. Submit electronic configuration files for each programmed protective relay and provide final Modbus data addressing maps documenting Modbus address and contents of all variables available over the Modbus link. The machine readable documentation shall be 100 percent compatible with the Software Listings previous defined and include all documentation files including logic and annotation files. Any changes made during or after factory acceptance test shall be incorporated.

PART 2 PRODUCTS

2.1 SWITCHGEAR

A. Equipment configuration:

1. 25 kV, 3 Phase, 3 Wire, 60 Hz

2. Power circuit breakers shall have the following symmetrical ratings in accordance with ANSI Standard C37.06.

a. Maximum RMS interrupting current rating: 25 kA

b. Nominal RMS voltage class: 27 kV

c. Maximum rated RMS voltage: 27 kV

d. Crest impulse voltage (BIL): 125 kV

e. Rated interrupting time: 3 cycles

f. Momentary closing and latching capability: 68 kA Crest at 2.7 K times rated short circuit current

g. DC close, trip, and spring charge power: 48 VDC from battery source as shown on the drawings and as provided under Section 16240.

B. The continuous current rating of each circuit breaker shall be as shown on the Drawings.

C. The continuous current rating of the bus shall be as shown on the Drawings. The bus shall be designed to carry its rated continuous current in the specified ambient temperature without exceeding the temperature rise limits specified in ANSI Standard C37.20.2. The bus supports, bus and connections shall be designed to withstand the specified circuit breaker close and latch short circuit current. Line and load bus connections to circuit breakers shall be rated to carry the full continuous current of the device frame.

D. The switchgear and protective devices shall be designed for continuous operation at its maximum rated current in a 40 degree C ambient temperature.

E. Coordinate all controls and applications for the PG&E standard “A”, “C”, “B” phase rotation.

F. Acceptable Manufactures: ABB/General Electric Power/Vac; Eaton Corporation, VAC-Clad-W; Schneider/Square D, Masterclad; Siemens, GM38; or equal by suitable, qualified system integrator as specified herein.

2.2 CONSTRUCTION

A. Structure

1. Switchgear shall be metal-clad, built-in dead front, free standing switchgear completely metal enclosed and sectionalized to isolate and minimize the effects of internal short circuit currents. The structure shall consist of a framework of preformed steel channels or angles covered with bolted steel sheets. Each individual breaker/metering cell shall be completely segregated from adjacent compartments and sections by grounded steel barriers at top, bottom, rear and sides. The structure shall be housed in a NEMA 3R walk-in enclosure.

2. Outdoor switchgear shall be housed in a factory assembled, prewired, weatherproof, NEMA 3R, walk-in modular steel enclosure. Access doors shall be gasketed with external padlockable door latch. Full height, hinged and gasketed, padlockable rear section doors shall be provided. Shielded ventilation louvers shall provide air circulation within the structure while excluding insects, vermin, moisture, and dust. Provide removable filter elements on all louvered exterior openings. Provide a structural steel base with lifting lugs and jacking plates to support the switchgear and floor plates. Provide removable steel cover plates over conduit entrance areas. A bituminous or other corrosive resistant undercoating shall be applied to the base and to the underside of the floor.

3. Provide the following accessories served from external 120V power source as shown on the Drawings. Provide enclosure resident panelboard for internal distribution to enclosure loads:

   a. One interior light per vertical section

   b. Light switch at each end wall

   c. Space heaters in each breaker and auxiliary compartment

   d. One GFI protected convenience outlet

   e. 12 Pole circuit breaker distribution panelboard conforming to Section 16441

4. Breaker compartments shall be equipped with grounded metal shutters to protect against contact with the energized primary disconnects when the breaker is removed from its compartment. Each individual breaker cell, metering and auxiliary compartment shall be provided with a hinged front panel door.

5. Provide side barriers between adjacent vertical structures in cable and bus compartments.

6. Rear cable compartments shall be isolated from the main and riser bus by insulated or grounded steel barriers. Cable compartments shall have adequate space for terminations and accessories. Provide hinged and bolted covers on the rear of each vertical section.

7. Conduit entry shall be bottom fed as shown on the Drawings.

8. Cubicles shown on the Drawings designated as “SPACE” shall be fully configured for future installation of circuit breaker, protective devices, and auxiliary equipment not included under this Contract. SPACE cubicles shall be fully bused, wired out, with all necessary control and power circuitry to allow insertion of new circuit breakers and protective equipment without requiring field busing or wiring modifications.

B. Auxiliary Sections

1. Provide bus extensions and compression lugs for number and size of incoming cables as shown on the Drawings.

2. Provide an auxiliary section to include a utility metering compartment. Metering compartment shall include CT bus bars, door with concealed hinges, 3-point catch and lock, handle seal and top, bottom, and rear barriers. Metering sequence and compartment arrangement shall conform to the specifications of the Power Company. In the event of a conflict, the Power Company Specifications shall supersede the Contract Documents.

3. Provision for AT&T telephone service in the auxiliary section for monitoring of switchgear per PG&E requirements. Coordinate telephone service requirements with AT&T and provide mounting space for telephone service components.

C. Buses and Connections:

1. Main and riser bus shall be copper with a flame retardant, track resistant insulation system rated for 105 degree C operation. Bus joints shall be silver plated, bolted and insulated with removable PVC boots.

2. The main and vertical riser busses shall be enclosed in a segregated metal compartment with removable covers for accessibility. Horizontal bus supports between adjacent cubicles shall be flame retardant, track resistant molded glass-reinforced polyester through-bushings. Provide horizontal bus extending through the entire switchgear line-up including space cubicles.

3. Circuit breaker load side runbacks shall be copper bus with epoxy insulation and porcelain support bushings. Provide two hole NEMA drilling for two cables per phase at each cable connection point.

4. Circuit breaker primary connections shall be mounted in molded glass-reinforced polyester insulated contact tube assemblies, bolted to the rear of each breaker cell compartment.

D. Grounding

1. Make provisions for connection of incoming and outgoing cable sheaths and for the copper grounding conductors shown on the Drawings.

2. Provide a continuous horizontal ground bus extending through the entire length of the switchgear. Bus material and short circuit rating shall be equal to the main bus. The ground bus shall have at least one bolted connection to the structure in each bay.

3. Provide a ground bus riser assembly in each cable compartment connected to the ground bar in each circuit breaker or potential transformer drawout assembly compartment. Connect metering, relaying and instrument transformer grounds to this riser assembly.

4. Provide a grounding disconnecting device between each circuit breaker removable element and the equipment ground bus which shall maintain contact at all times, except when the primary disconnecting devices are separated at a safe distance.

5. Provide a static grounding device on each voltage transformer drawout carriage to contact the primary fuses in the disconnected position. Each drawout carriage shall be bonded to the ground riser bus assembly.

E. Power Circuit Breakers

1. Circuit breakers: Removable, electrically operated, vacuum interrupter type with stored energy trip/close mechanism, mounted in a heavy gauge steel frame with a removable front panel cover. The following mechanical indicators and devices shall be visible and accessible at the circuit breaker:

   a. Manual trip/close pushbutton

   b. Open/close indicator

c. Operations counter

d. Spring charge indicator

e. Manual charging arm

f. Racking screw

2. Each breaker cubicle shall have a self-contained racking mechanism to move the breaker between the TEST/DISCONNECT and CONNECTED positions and to align and secure the primary disconnects in the CONNECTED position.

3. Circuit breakers shall be capable of being racked in or out with the compartment door closed. Provide interlocks to prevent the following operations:

   a. Racking a closed breaker into or out of the CONNECTED position.

   b. Closing a circuit breaker until it is fully racked into the TEST/DISCONNECT or CONNECTED position.

   c. Withdrawing a circuit breaker from the cubicle while the closing springs are charged. The operating springs shall be discharged automatically when the breaker is inserted or removed from the compartment or is moved between the TEST/ DISCONNECT and the CONNECTED position.

   d. Insertion of a breaker of incorrect ampere rating or inadequate interrupting capacity.

4. Means shall be provided for padlocking the breaker racking mechanisms in either the CONNECTED or TEST/DISCONNECT position.

5. Provide an emergency mechanical trip lever to allow manually tripping the breaker in the event of loss of tripping voltage. Local manual operation shall be possible from the front of the circuit breaker by direct mechanical linkages without the use of auxiliary voltage or other auxiliary medium. The closing mechanism shall be “trip-free”.

6. Each breaker shall have a secondary control power plug which automatically engages a cell mounted mating receptacle in the CONNECTED position and disengages as the circuit breaker is racked out to the TEST/DISCONNECT position. Provide a means to manually engage the control power plug in the TEST/DISCONNECT position.

7. Breaker contacts on the removable element, truck operated cell (TOC) auxiliary switch shall be wired to terminal blocks. Provide two spare “a” (normally open) and two spare “b” (normally closed) auxiliary contacts in addition to the contacts required for breaker operation. Normally closed auxiliary contacts shall break before the normally open auxiliary contacts make.

8. Circuit breakers shall be equipped with mechanism operated cell (MOC) auxiliary switch contacts for remote status indication. Provide two spare "a" (normally open) and two spare "b" (normally closed) auxiliary contacts wired to terminal blocks for monitoring circuit breaker TRIP status.

9. Circuit breaker frame sizes shall be as shown on the Drawings.

10. Each breaker shall have separately fused close and trip circuit.

11. Circuit breaker status contacts and position contacts (OPEN and CLOSE) shall be from the circuit breaker and cell mechanical switches. If additional contacts are needed for the control scheme, truck operated (TOC) and mechanism operated (MOC) contacts shall be used. The use of auxiliary relays shall not be acceptable.

F. Surge and Lightning Arrestors

1. Surge arrestors: Provide a set of three intermediate class surge arrestors on the line side of each incoming main circuit breakers for protection from lightning, switching, and other transient events.

2. Arrestors shall be designed and manufactured in accordance with ANSI/IEEE C62.11.

3. Provide polymer type, metal oxide varister disk surge arrestors nominally rated at 27 kV with Maximum Continuous Operating Voltage Rating of 22 kV.

4. Provide arrester with pressure relief feature to externally vent upon failure of the arrester components.

5. Acceptable Manufactures: ABB/General Electric Tranquell; Eaton Corporation/Cooper Power System, Type UI; or equal.

G. Control Power

1. Each breaker shall be electrically operated at 48 VDC from the battery system specified in Section 16240. Breaker operating mechanism shall be electrically charged, stored energy type. Charging motor shall include a limit switch feature and an anti-pump relay. Include provisions for manual charging of the mechanism.

2. Control power shall be provided from interconnected 48 VDC battery cells, mounted in a rack in a separate switchgear enclosure per Section 16240.

3. DC control circuits shall utilize circuit breaker protection conforming to utility interconnection requirements as necessary. Fused protection of control circuits shall not be acceptable unless required by the serving utility.

H. Secondary Wiring

1. Wiring: 600 Volt, stranded copper, type SIS, flameproof switchboard wire, minimum size No. 12 AWG for control, No. 8 AWG for power and instrument transformer secondaries. Wiring shall be grouped together with harnesses or in ducts and shall be secured to the structure. Pull out type fuse holders shall be used for control circuits.

2. All outgoing control wires shall be brought to master terminal blocks with suitable numbering strips as shown on the drawings.

3. Identification and termination: Ring type, crimp on wire lugs with sleeve type wire markers at each termination point. Markers shall be heat stamped with circuit origin/destination information. Terminal blocks shall be rated 20 Amps minimum, 600 Volt, screw type with white marking area. Current transformer secondaries shall be wired to sliding link shorting type terminal blocks.

4. All wiring shall be neatly placed in suitable troughs or raceways. At locations where wires cross from stationary to swinging panels flexible stranded conductors shall be installed neatly bundled in a loop of sufficient length to prevent excessive strain on the conductors. Wiring shall be installed in plastic wireway with side slots and shall be secured to cubicle surface with screws (adhesive clamps are not acceptable).

5. All secondary and control wiring within the high voltage compartment shall be completely shielded in a protective grounded metal covering and shall be stranded. Instrumentation cable shields shall be grounded at one point at the control end only. Shielded cables shall not be placed in close proximity to high current or voltage carrying circuits.

6. Provide all circuit breakers and enclosures fully wired out to terminal strips for zone interlocking, maintenance switching, or other control interlocking functions provided under this Contract. All wiring, potential bus, necessary fuses, and terminal blocks required within each unit shall be furnished and installed.

I. Metering Transformers

1. Current Transformers (CTs):

a. Current transformers: Dry type, suitable for service within medium-voltage switchgear. Designed to have a mechanical and thermal rating to withstand short-circuit current, stresses, and heating effects equal to the rating of the circuit breaker of the application.

b. Provide multi-ratio current transformers for relay circuits unless otherwise indicated. Provide single ratio current transformers for dedicated metering circuits. Rating shall be as indicated. Provide multi-ratio current transformers with available taps as follows:

Bus Rating (in amperes)	Multi-Ratio CT
1200	100/200/300/400/500/600/800/900/1000/1200 : 5A

c. Current transformers: window type, rated in accordance with ANSI Standard C57.13, location and quantity as shown.

d. Ratings:

a. Provide 0.3 % ANSI accuracy class current transformers for metering applications at rated current at rated burden of the metered circuit.

b. Accuracy of the current transformers shall be suitable for the burden imposed on them from the final equipment interconnections provided by the system integrator. Provide minimum ANSI Class C-200 multi-ratio current transformers for relay applications.

e. Leads:

a. Multi-ratio CTs shall be 5 lead type. Single-ratio CTs shall be 2 lead type.

b. Wire all CT taps out to sliding link short-circuiting terminal blocks whether active or not.

c. All CT terminals shall be ring-type.

d. CT leads shall use minimum #10 AWG, ASTM B3 or B8 copper with Class B stranding per ASTM B8.

e. CT leads shall be marked with permanent sleeve markers.

f. Current transformers shall be identified for polarity with standard markings or symbols.

g. Provide current transformers capable of carrying rated primary current continuously without damage.

h. Install secondary wiring from current transformers in a suitable wiring trough, or conduit to specified short-circuiting type terminal blocks for connection to relays, instruments, and other devices.

i. Provide compartment enclosed by metal plates to separately house current transformers in each unit. Provide metal barriers to isolate each current transformer from other component parts and adjacent circuits. Overlapping removable covers shall be provided to give access to the current transformers.

j. All ratios of each multi-ratio current transformer shall be extended by wires to terminal blocks, located in the instrument compartment. All wires shall be tagged with their phase.

k. Acceptable Manufactures:

a. ABB/General Electric Company

b. Schneider Electric/Square D Company

c. ITI

d. Approved equal

2. Voltage Transformers (VTs):

a. Each three-phase VT application shall be composed of three single-phase VT's connected wye-ground/wye-ground unless shown otherwise on the Drawings. Secondary voltage for metering and relaying shall be 208Y/120V, three-phase, four wire.

b. Provide dry type voltage transformers, 60 Hz, and with an accuracy classification as determined according to ANSI Standard C57 as specified, and suitable for the burden imposed upon them. Voltage transformers shall meet the following minimum requirements:

a. Nominal system voltage: 22 kV

b. Maximum system voltage: 25 kV

c. BIL: 125 kV

d. Primary to Secondary Ratio: 100:1 or as required

e. Accuracy Class per ANSI Standard C57: 0.3 MWXYZ, 1.2ZZ

f. Minimum thermal burden rating at 30/55 degrees Celsius: 2000/1500VA

c. Transformers shall be identified for polarity with standard markings or symbols. Secondaries shall be fused and connected to potential buses as required. Secondaries with neutrals shall be grounded.

d. High potential transformers shall be mounted on a drawout or trunion device which, when in the OPEN position, shall disconnect both primary and secondary terminals of the transformer and ground the primary potential fuses. The transformers shall be mounted in a separate steel enclosed compartment. Compartment doors shall be connected to the drawout device in such a manner that when the door is opened, both high voltage and low voltage terminals shall be disconnected, and transformers and fuse assembly shall move forward. Forward movement shall not interrupt the ground connection to the transformer cases. When transformers are in the FULLY WITHDRAWN position, the high voltage terminals of the transformers and the potential fuses shall be grounded.

e. Acceptable Manufactures:

a. ABB/General Electric Company

b. Schneider Electric/Square D Company

c. ITI

d. Approved equal

J. Terminal blocks:

1. Terminate control wiring in molded, screw-type sliding link style terminal blocks. Wiring shall use spring spade-type terminals except for current transformer wiring which shall use ring-type terminals.

2. Route outgoing control wires to master terminal blocks with white strips numbered in agreement with the manufacturer's detailed wiring diagrams and the drawings.

3. Provide terminal blocks rated 600V, 50A, number of poles as required, front connected, with stainless steel linking screw, and engraved white marker strip. Provide shorting type terminal blocks for CT applications.

4. Provide short circuit type terminal blocks for all current transformer secondary circuits and test terminals. Units shall have integral and automatic short circuiting when disconnecting link is exercised. There shall be no undefined intermediate positions.

5. Spares: provide minimum 15% spare points or 25, whichever is greater for each cubicle and unit.

6. Acceptable manufacturers:

   a. ABB/General Electric Co. Type EB

   b. Phoenix Contact

   c. WAGO

   d. AVO International

   e. Approved equal

K. Marking and Identification

1. Provide nameplates as specified in Section 16075.

2. Provide permanent master nameplate for switchgear designation, manufacturer's name, model number, order number and voltage, current and interrupting ratings.

3. Provide nameplates for internal unit components including relays, timers, switches, or other equipment shown on the control schematics.

4. Provide permanent warning signs marked "DANGER - HIGH VOLTAGE - KEEP OUT" on each rear compartment door. Signs shall be OSHA approved.

5. Provide a phase rotation marker on the incoming line compartment of each switchgear line-up.

6. Provide arc-flash warning labels per Section 16080.

2.3 PROTECTIVE RELAYS

A. General

1. Unless otherwise specified to comply with PG&E standards, microprocessor-based digital protective relays shall be provided and conform to ANSI C37.90. Relay circuit boards shall have conformal coating for environmental protection.

2. Provide relays having Modbus TCP interface for each relay. Relays shall include full addressing of all monitored variables.

3. Provide relay to relay communication for protective functions using IEC 61850 protocol with suitable switches and network interface connections to relays.

4. The relays shall have at least one LED each for trip, for alarm, and for "Relay Healthy" indication.

5. Relays shall provide non-volatile fault locator and record the last ten faults registered in a non-volatile event recorder. Recorder shall store a minimum of the previous 256 events experienced by the relay.

6. All relay settings shall be stored in a non-volatile memory.

7. All relays for use as part of the utility primary service interconnection shall be included on PG&E's Approved Relay List. Where general relay requirements may conflict with PG&E applicable devices, the features of the PG&E approved relay shall govern.

8. Provide semi-flush mounting in a 19-inch rack assembly located in the control section of the Switchgear using a mounting plate for side-by-side mounting of relays.

9. Provide manufacturer's standard relay configuration software for programming relays, testing, commissioning, and data acquisition and export. All software shall be licensed to the City. Provide relay configuration software by Schweitzer engineer Laboratories (SEL) AcSELerator Quickset; equivalent Mulitlin; or approved equal.

B. Feeder Protection Relays and Arc Flash Detection Relays (50/51, 50N/51N, 67, 27, 59)

1. Three-phase, multi-function microprocessor-based time and instantaneous overcurrent relay with 10 software-selectable curves, LED targets, and auxiliary output contacts.

2. Approved by PG&E for primary service interconnection.

3. Power requirements: 48VDC

4. Provide three phase time overcurrent and ground overcurrent (Device 51/51N) with a minimum of 16 selectable characteristic curves for both the phase and ground overcurrent functions. Time overcurrent pickup point shall be independently selectable for phase and neutral. Provide full multi-function standard protection features from the relay manufacturer with specific additional protection features (optional or standard) where specified or shown on the Drawings.

5. Provide three phase instantaneous overcurrent and ground overcurrent (Device 50/50N). Instantaneous overcurrent feature shall be adjustable over a minimum 1 time to 40 times the phase overcurrent pickup point. Provide independent neutral instantaneous overcurrent protection.

6. Provide main breaker relays that include at a minimum additional integral three phase directional overcurrent protection (67), undervoltage protection (27), under/over frequency protection (81), and overvoltage protection (59).

7. Provide electronically latched target indicators for visual indication of the faulted phase, faulted neutral, and source of the protective function (time or instantaneous). Provide integral test capability for executing an operational check of the relay, confirming the integrity of outputs, status lights, and targets.

8. Provide Trip/Close circuit supervision for breaker coils.

9. Provide Push-To-Test output pushbutton. Push-To-Test function shall be guarded from inadvertent operation by finger guards or other protective features.

10. Provide the following options:

    a. Phase and neutral current inputs: 5A

    b. Standard firmware plus arc sense technology

    c. 48 VDC power supply and 48 VDC digital input

    d. Dual 100Base-FX Ethernet multimode fiber optic communication ports with LC connectors and additional EIA-232 rear serial port. Provide Modbus TCP communications protocol converter if required for interfacing to plant SCADA.

    e. IEC 61850 network interface.

    f. Four (4) Discrete Inputs (DI) and four (4) Discrete Output (DO), individually programmable with fast high current interrupting outputs.

    g. Four (4) Discrete Inputs (DI) and four (4) Discrete Output (DO), individually programmable with fast high current interrupting outputs.

    h. Minimum four (4) arc flash detection inputs.

    i. Individual 3-Phase AC phase current inputs, neutral AC current input, and 3-Phase AC voltage inputs.

    j. Conformal coated circuit boards.

11. Provide light-sensing arc flash detection protection relays combining over current detection with light sensing devices for breaker tripping functions. Relay shall provide high speed tripping upon simultaneous sensing of both overcurrent and visible arc flash light.

12. Provide fiber optic light sensors for multi-point monitoring of arc flash conditions.

    a. Provide bus bar monitoring with bare fiber optic sensors detecting arc flash light over the entire sensor length.

    b. Provide breaker contact and termination monitoring with point fiber optic sensors.

    c. Sensor number and equipment monitoring points shall be as schematically shown on the Drawings. Final sensor mounting and location shall be as recommended by the relay manufacturer and switchgear supplier.

13. Acceptable Manufactures

    a. Schweitzer Engineering Laboratories (SEL), 751A

    b. ABB/General Electric Co./Multilin

    c. Approved equal included on PG&E approved list of relays

C. Arc Flash Detection (AFD) Fiber Optic Cables:

1. Provide arc flash detection fiber optic cable assemblies for monitoring arc flash events at locations shown on the drawings. Provide omnidirectional point sensor assembly consisting of plastic optical fiber point sensor, connected to termination points using poly-ethylene jacketed duplex zipcord cable. Provide mounting hardware kit for each point sensor provided.

2. Provide fiber extension cables, ST terminations, fittings, special tools, and other accessories to allow connection of the fiber optic sensor to the arc flash protection relay interface connectors as specified herein.

3. Provide terminations, tools, and accessories as recommended by the manufacturer that are necessary for a complete installation and normal maintenance.

4. Acceptable manufacturers:

   a. Schweitzer Engineering Laboratories C804, Multimode Fiber-Optic Arc Flash Detection (AFD) Sensors and C814, Arc Flash Detection fiber cables, tools, and accessories.

   b. ABB/General Electric Co./Multilin

   c. Approved equal

D. Lockout Relay (86)

1. Auxiliary high-speed, multi-contact, lockout relay, manual reset, 48 VDC, oval handle, 13 ohm coil, with contact configuration as shown on the Drawings. Provide with a white indicating light wired to monitor the trip coil of the relay.

2. Acceptable manufacturers

   a. Electroswitch Series 24 LOR, Model 780.

   b. ABB/General Electric Co. Type HEA.

   c. Approved equal

E. Auxiliary Relays

1. Provide draw out type auxiliary relays for additional control, alarm, or monitoring functions where required. Units shall be voltage or current operated as required for the application. Provide relay with target for visual indication of relay condition. Relay contacts shall have a minimum rating of 30A instantaneous and 6A continuous.

2. Acceptable manufacturers:

   a. ABB/General Electric Co., Type HAA.

   b. ABB

   c. Approved equal

2.4 AUXILIARY DEVICES

A. Provide two indicating lights (red and green) for each breaker and one indicating light (white) for each lockout relay, when provided. The indicating lights shall be Eaton Corporation, General Electric Co.; Schneider Electric/Square D; or approved equal and shall be provided with LED lamps.

B. Control Switches

1. Circuit breaker control (Devices CS)

a. Hand operated for manual control, with trip-close and spring return to normal. Provide contact configuration as shown on the drawings. 48VDC.

b. Acceptable manufacturers

a. ABB/General Electric Company Type SB-1.

b. Schneider Electric/Square D Company

c. Electroswitch Series 24, Type CSR.

d. Approved equal

C. Test Switches:

1. Provide test switches for each current, voltage, and power meter circuit.

2. Provide switch assembly for multi-circuit testing of relays and meters. Provide three rack-unit modules for mounting in standard 19-inch rack panel with clear plastic covers.

3. Provide specific nameplate identification for each test switch mounted above each test switch.

4. Provide barriers around voltage switches and provide short circuiting type current switches with test jacks.

5. Acceptable manufacturers

a. SECO ST

b. ABB

c. Approved equal.

2.5 INSTRUMENTATION AND METERING

A. Provide power metering type and quantity as shown on the Drawings and as specified in Section 16290.

B. Provide connection and configuration to switchgear resident network switch for remote access of power system variables as specified in 16290.

2.6 SWITCHGEAR REMOTE MONITORING AND BREAKER CONTROL PANEL: MVSG1

A. General

1. Provide remote control and monitoring capability for switchgear equipment, circuit breakers, electronic devices and other critical components as specified.

2. Provide HMI device, programmable logic controllers, network switches, relays, test switches, UPS, and other components as specified or shown on the Drawings. Provide components mounted in a dedicated enclosure within the MVSG1 walk-in enclosure for remote circuit breaker operation, status monitoring, and alarming as specified and shown on the Drawings.

3. Provide Ethernet Modbus TCP network connectivity between switchgear and HMI control panel. If alternate networks or individual hardwired connections are required to implement the control and metering functionality specified, provide all necessary additional conduit, wire, terminations, specialty terminations, testing, and other appurtenances and services for a fully functioning, fully tested system all at no additional cost to the City.

4. Control panel shall be fully powered from the 48VDC battery power source and DC power panel per Section 16240.

5. Provide additional, dedicated configured Ethernet port for remote communication of equipment monitored circuit breaker and power monitoring variables using Ethernet Modbus TCP to City networks as shown on the Instrumentation Drawings. Coordinate equipment IP addresses with City Ethernet addressing requirements to be provided to the Contractor upon request.

6. Provide integral interface to a laptop computer for configuration, diagnostics, and troubleshooting of the switchgear components.

7. Provide status monitoring of circuit breaker Open, Close, and Trip for all switchgear circuit breakers for remote monitoring by the existing plant SCADA system via Ethernet/Modbus TCP communications.

8. The panel dimensions shown on the Drawings and noted herein are for general reference only. The System Integrator shall be responsible for ensuring final enclosure sizing and panel arrangements accommodate all required equipment for a fully integrated and operational system as required by the Contract Documents.

9. Control panels shall conform to the requirements of the NEC Article 409.

10. Control panel shall be manufactured and assembled per the requirements of UL 508A. The complete assembly shall bear the UL label as an Industrial Control Panel as defined by UL 508A. If required for UL labeling, provide ground fault protective devices, isolation transformers, fuses and other equipment as necessary to achieve compliance with the UL standard. The Drawings do not detail all UL requirements. Where enclosures contain instruments mounted through the enclosure walls or doors, panel construction shall meet all requirements of UL labeling as described above, but no UL label is required. This exception applies only if UL Recognized instruments or devices for the intended purpose are not made.

B. Panel Enclosure:

1. Freestanding swing out 19” rack capable of 48 rack units, 20-inch deep rack frame, 96-inch external height with 7.5-inch spacers between racks. Provide left, right, upper, mid, and lower wireways, wire channel and covers, endcovers, and bracket for ground bus.

2. Provide panel and rack unit conforming to IEEE 693 high seismic qualifications.

3. Panels shall be of continuous welded steel construction. Provide steel angle stiffeners as required on the back of the panel face to prevent panel deflection under instrument loading or operation. Internally the panels shall be supplied with a structural steel framework for instrument support purposes and panel bracing. The internal framework shall permit panel lifting without racking or distortion.

4. Each panel shall be suitable for terminal block and component mounting on side panels within the rack enclosure. Panel fabrication shall ensure sufficient slack wire lengths to allow full panel swing for both front and rear access to components and termination points.

5. Provide enclosure with pad lockable door handles with three-point latching hardware.

6. The panels, including component parts, shall be constructed and assembled in a thoroughly workmanlike manner and shall be free from sharp edges and welding flaws. Wiring shall be free from kinks and sharp bends and shall be routed for easy access to other components for maintenance and inspection purposes.

7. Instruments, devices, and protective relays designed for rear of component wiring shall be installed on arranged within the enclosure on swingout panels in a manner to facilitate access, maintenance, and adjustment.

8. The panels shall be completely fabricated, with components and instruments installed and wired at the switchgear system integrator's facility.

9. All components shall be mounted in a manner that shall permit servicing, adjustment, testing and removal without disconnecting, moving or removing any other component. Components mounted on the inside of panels shall be mounted on removable plates and not directly to the enclosure. Mounting shall be rigid and stable unless shock mounting is required otherwise by the manufacturer to protect equipment from vibration.

10. All exterior panel and door mounted equipment shall be installed with suitable gaskets, faceplates, etc. required to maintain the NEMA rating of the panel. Where shown on the Drawings provide additional component protective covers and/or hinged access panels.

11. Nameplates

    a. All panels and panel devices shall be supplied with suitable nameplates which identify the panel and individual devices.

b. Components mounting shall be oriented in accordance with the internal components shall be identified with suitable plastic or metal engraved tags attached with drive pins adjacent to (not on) each component identifying the component in accordance with the Drawings, Specifications, and System Integrator's data.

c. Each device nameplate for panel internal devices shall be a suitable generic identifier for that device (e.g., Power Supply 1, XFMR,). Provide nameplates above the PLC and I/O rack slots showing the card slot number (S1, S2, etc.). Interior panel nameplates shall be vinyl film type with permanent adhesive. Provide Brady Minimark or equal. The letters shall be black against a white background, ¾-inch minimum size.

d. Provide nameplates or 1-in by 3-in engraved nameplates with 1/4-in lettering for identification of panel and any door mounted control devices, pilot lights and meters. Panel exterior nameplates shall be 3/32 inch thick, black and white, Lamicoid with engraved inscriptions. The letters shall be Black against a White background unless otherwise noted. Edges of the nameplates shall be beveled and smooth. Nameplates with chipped or rough edges will not be acceptable. Nameplates shall be affixed to the panel exterior as required to maintain UL Type rating of the enclosure.

C. Mounting Elevations

1. ISA Recommended Practice RP60.3 shall be used as a guide in layout and arrangement of panels and panel mounted components. Dimensions shall account for all housekeeping pads that panels will sit on once they are installed.

2. Centerline of operator interface terminals (field HMIs) and process indicators shall be located no lower than 48 inches or higher than 66 inches above the floor on a panel face.

3. Centerline of lights, selector switches and pushbuttons shall be located no lower than 32 inches or higher than 70 inches above the floor on a panel face.

4. Tops of operator interface terminals (field HMIs), process indicators, and lights shall be located no higher than 86 inches above the floor on a panel face.

5. Installation of panel components shall conform to component manufacturers' guidelines.

D. Arrangement

1. Instruments, devices, and protective relays designed for rear of component wiring shall be installed on arranged within the enclosure on swingout panels in a manner to facilitate access, maintenance, and adjustment.

2. The panels shall be completely fabricated, with components and instruments installed and wired at the switchgear System Integrator's facility.

3. All components shall be mounted in a manner that shall permit servicing, adjustment, testing and removal without disconnecting, moving or removing any other component. Components mounted on the inside of panels shall be mounted on removable plates and not directly to the enclosure. Mounting shall be rigid and stable unless shock mounting is required otherwise by the manufacturer to protect

equipment from vibration. Components mounting shall be oriented in accordance with the internal components shall be identified with suitable plastic or metal engraved tags attached with drive pins adjacent to (not on) each component identifying the component in accordance with the Drawings, Specifications, and System Integrator's data.

4. Mounting Elevations

    a. ISA Recommended Practice RP60.3 shall be used as a guide in layout and arrangement of panels and panel mounted components. Dimensions shall account for all housekeeping pads that panels will sit on once they are installed.

    b. Centerline of operator interface HMI shall be located no lower than 48 inches or higher than 66 inches above the floor on a panel face.

    c. Centerline of lights, selector switches and pushbuttons shall be located no lower than 32 inches or higher than 70 inches above the floor on a panel face.

    d. Installation of panel components shall conform to component manufacturers' guidelines.

E. Terminal blocks:

1. Relay test voltage and cutouts:

    a. Trip cutout switches: Yellow handle, single pole, front-connected potential assembly. Mount on rear of ROP 19-inch rack.

    b. Grounding cutout switches: Green handle, single pole for use for current transformer single point grounding

    c. Power supply cutout switches: Red handle, two pole for 48VDC and 120VAC power supply circuits

    d. Acceptable manufacturers:

        a. States Type SMH

        b. Or equal

2. Field terminal blocks

    a. 30 ampere, 600V, with brass screw terminals and white marking strip. Mount on rear of ROP 19-inch rack.

    b. Acceptable manufacturers

        a. AVO International, States Type NT. Provide shorting type terminal blocks for current transformer circuits.

        b. Or equal.

F. Control Switches:

1. Relay cut-out:

a. Oval handle two position rotary switch, 90 degree snap action, double-pole, double-throw, 10A at 125 VDC, standard indexing with nameplate engraved “CUT IN” at vertical and “CUT OUT” at right hand 45 degree position.

b. Function:

a. Provide yellow handle single pole for trip cutout switches

b. Provide green handle single pole for CT grounding cutout switches

c. Provide red handle two pole for power supply cutout switches

c. Acceptable manufacturers:

a. States SMH

b. Electroswitch Series 101, Model 102602.

c. Or equal

2. Panel fillers:

a. Mount control switches on 3-RU high, 19 inch panel fillers prepunched for the number of control switches shown on the drawings.

b. Acceptable manufacturers:

a. Electroswitch.

b. Schweitzer Engineering Laboratories.

c. Or equal

G. Pilot devices:

1. Pushbuttons:

a. 30.5mm, oiltight, heavy-duty, DPDT, momentary contact, rated 10 ampere continuous, 600 VAC maximum. Double-block (2 NO, 2NC) operator, standard blue cap, and flush ring.

b. Acceptable manufacturers:

a. Allen Bradley

b. General Electric CR104PB.

c. Cutler-Hammer 10250T.

d. Or equal

2. Indicating Lights:

    a. LED type, green (circuit breaker open), red (circuit breaker closed), and blue (circuit breaker tripped).

    b. Power supply voltage: 48 VDC.

    c. Acceptable manufacturers:

        a. General Electric Type ET-16.

        b. Data Display Products PL16.

        c. Or equal

H. Discrete Input/Output (I/O) Interface

1. Provide discrete I/O devices incorporated into the Switchgear. I/O interface shall be used for implementing the specified control and status monitoring schemes.

2. The total number of digital input and output points shall be determined by the switchgear supplier to implement the protection and status monitoring schemes as described in these Specifications plus a minimum of 20% spare points of each type provided.

3. Provide interposing relays or high current-interrupting electronic relay type output contacts to interface the controller outputs with the circuit breaker close and trip circuits.

I. Human Machine Interface

1. Provide HMI color view screen, backlit liquid crystal display (LCD) with minimum Accessories

2. Touch Screen

    a. Provide HMI touch screen for 19" rack mount, with 19” viewable area, 1280x1024 resolution, resistive touch screen, and 48 VDC power supply.

    b. Provide Transduction TR-LCD1900-RM-TOUCH-48VDC, or equal.

    c. Provide HMI graphical software to provide the necessary system control screen specified herein.

3. Keyboard drawer

    a. Provide 104 key with touch pad for 19” rack mount.

    b. Provide Xymphony LCDK, or equal.

J. Panel Mounted (Industrial Grade) Ethernet Switches

1. Provide industry-standard ultra-wide IEEE 802.3u 100Base-TX and 100Base-FX autosensing Ethernet switches supporting Fast Ethernet communications over both fiber optic (FO) and copper cables.

a. Provide managed Ethernet switches with a minimum of sixteen 100Base-TX ports and two 100Base-FX ports. FO ports shall be multi-mode type with type LC connectors.

b. Switch shall be standard 19-inch rack mount type for industrial application having a minimum operating temperature of 60 degree C, and listed for installation in a UL508 control panel.

c. Provide network switch powered from the panel 48VDC power supply.

d. Provide conformal coated circuit boards.

e. Switches shall include an alarm relay contact output rated for 1 amp at 24VDC.

2. Managed switches shall be SEL 2730M, Moxa, N-Tron, or approved equal.

K. Grounding:

1. Provide an internal 2 inch by ¼ inch by 18 inch long copper ground bus located at the bottom of each panel. Mount ground bus directly above the lower terminal block group.

2. Drill and tap ground bus in a staggered pattern every 3/4 inch for 10-32 screws.

3. Provide instrument transformer secondary circuit, protective relays and other devices having a case ground stud or requiring a specific circuit ground, with a ground connection to the internal ground bus, with a #12 AWG minimum green colored copper wire and a bolted terminal lug. Effectively ground the remainder of the devices through the enclosure structure.

L. Acceptable manufacturers

1. ABB/General Electric

2. Eaton Corporation

3. Tesco Controls

4. Industrial Electrical Manufacturing (IEM).

5. Meyers Power Products

6. Powercon Engineering

7. Schneider/Square D

8. Siemens; or equal.

2.7 SURFACE PREPARATION AND SHOP COATINGS

A. All non-current carrying metal parts of the switchgear assembly shall be cleaned of all weld spatter and other foreign material and given a hot iron-phosphate chemical treatment. Apply a rust inhibitive, heat cured epoxy primer prior to finish coat.

B. Unpainted non-current carrying parts shall receive a protective zinc plating to prevent corrosion. Printed circuit boards shall be coated with a protective conformal epoxy. All device contacts shall be silver plated.

2.8 FACTORY QUALITY CONTROL

A. Provide certified test data.

B. Provide standard performance test data results.

C. Switchgear:

1. Factory test per IEEE C37.20.2.

D. Power Circuit Breakers:

1. Factory test per IEEE C37.09.

E. Factory Demonstration Tests (FDT):

1. The switchgear supplier shall simulate true power system operation and provide three-phase voltage and current test inputs for relay and metering checkout. Provide DC control power at the voltage shown on the Drawings.

2. The factory demonstration tests shall demonstrate the following

a. Verification that all required field terminals for interface to external switchboards, control panels, DC power panels, and similar equipment have been provided.

b. Correctness of wiring from all panel field terminals to all switchgear components.

c. Proper workmanship and correctness of all internal switchgear wiring.

d. Proper operation of all switchgear hardware through a complete functional checkout of every relay, switch, and meter. The approved AC and DC schematics shall be proved and highlighted on a line-by-line basis.

e. Proper commissioning of all protective relays and functions in accordance with the manufacturer’s procedures.

f. Proper operation and testing of switchgear control, status, monitoring, and alarming at the control panel HMI.

g. Proper operation of the network communications following the favorably reviewed factory testing procedures for testing Modbus and Ethernet interface communications.

3. The switchgear supplier shall provide as many eight-hour testing days as required for a complete component-by-component functional checkout of each switchgear.

4. The switchgear supplier shall have an electrician or technician available for testing for the full duration of the test.

5. The City reserves the right to attend the factory testing at the switchgear manufacturer's facility. Provide a minimum of 4 weeks advance notice to the City of the scheduled test. Testing shall only be scheduled following favorable review of the submitted factory test protocol. All factory tests shall follow the favorably reviewed test protocol.

6. All factory test reports with punch list items shall be completed and the Construction Manager notified in writing before the switchgear is released for shipment.

PART 3 EXECUTION

3.1 INSTALLATION

A. The equipment shall be leveled and anchored directly to a concrete equipment pad or finished floor in accordance with approved anchorage submittals developed under Sections 01612 and 01614. Provide hardware and metal shims for installation. Grout and caulk all voids beneath the equipment base. Anchor bolts shall be sized and installed in accordance with Section 05500.

B. Install the equipment in accordance with the manufacturers' instructions.

C. Remove temporary lifting angles, lugs and shipping braces. Touch-up damaged paint finishes.

D. Make wiring interconnections between shipping splits.

E. Install bus splice plates and torque the connections.

F. Insulate the primary cable connections to bus pads and lightning and surge arrestors. Fill voids around bolted connections with 3M Brand SCOTCHFIL electrical putty and apply tape insulation or heat shrink insulating boots in accordance with the switchgear manufacturer's installation instructions.

G. Install primary cables in accordance with Section 16121. Bond cable sheaths to the switchgear ground bus. Install partial discharge sensors in accordance with manufacturer's recommendations.

H. Terminate foreign circuits entering the switchgear on isolation switch terminal blocks that meet the requirements of the state where the Project is located. Terminal blocks for foreign circuits or interlocks shall be yellow color.

I. Number wiring with shrink-type tag devices at both ends consistent with the manufacturer's detailed wiring diagrams. Duplication of wire numbers and terminal block numbers is not acceptable.

J. When a power source other than the source which is interrupted is present in the switchgear compartment, provide a switch for each remote source inside the compartment to isolate the source in compliance with the National Electrical Code.

K. Furnish wiring, potential bus, necessary fuses, and terminal blocks within each unit. Shield secondary and control wiring within the high voltage compartment in a protective metal covering.

L. Make relay and equipment settings and perform startup testing in conformance with the requirements of Section 16080.

M. Apply arc flash warning labels in accordance with Section 16080.

3.2 SYSTEM CONFIGURATION

A. General: Perform all system programming and graphical display development of the 21 kV power system and switchgear remote operating and monitoring status.

B. HMI Programming and Configuration

1. The HMI shall be provided with operating system and software to display the following screens. All software provided under this Contract shall be licensed to the City.

2. Screens shall be originally configured in the factory and shall be finalized during the factory startup/commissioning process. As a minimum the following screens, or functional equivalents, shall be incorporated into the HMI for end use by the City:

a. Main Menu Screen – Displaying choices of “ONE-LINE”, “ELEVATION”, “SEQUENCE OF EVENTS”, “SYSTEM HEALTH” , “USER SETTINGS” , “USER ADMINISTRATION”, MAINTENANCE”

b. Active One-Line Diagram – Displaying all the circuit breakers contained in the lineup and their active status as OPEN, CLOSED or TRIPPED. Active metering values for bus voltage for each phase and breaker current for each phase shall also be displayed. Touching a breaker symbol on the one-line diagram shall take the user to a screen containing metering data and status information for the particular breaker.

c. Physical Front Elevation Diagram – Displaying the general appearance and mechanical layout of the lineup. Touching a breaker cubicle on the elevation shall take the user to a screen containing metering data and status information for the particular breaker.

d. Sequence of Events Menu – This display will contain all the recorded events pertinent to the line-up (breaker events, alarm events, system events, etc.). These events will all be time stamped and all system events for the entire lineup shall be synchronized. The user shall be able to configure the preferences of events (FIFO, Auto Cleanup, etc.) and shall be able to filter the information shown.

e. System Heath Menu – This display will provide status indication of the central processors and individual circuit breaker electronics.

f. User Settings Menu – This display will allow the operator to view the configuration of the system and the individual settings associated with each breaker.

g. In addition to the General Menus and Diagrams listed above, provide the breaker status showing breaker contact position, closing spring status, protection status (enabled/disabled), metering showing all configured parameters.

h. Provide an additional six screens for monitoring and operations as directed by the City. Details of these additional screens shall be provided during startup and commissioning of the equipment.

C. Provide all protective overcurrent relay settings and interlocks as required per the electrical system studies performed under Section 16080.

D. Provide additional energy reducing maintenance switching function for each circuit breaker with HMI status indicator incorporated on all graphic screens.

E. Control panel shall be powered from the battery based control power source system supplied with the switchgear and energized from the 48V DV batteries specified under Section 16244 to ride through any momentary switching of control power sources.

F. Interface to City Process Control System

1. Provide system dry alarm contacts to switchgear resident I/O for networked status and alarming to City SCADA. Provide the following alarms at a minimum for each circuit breaker:

a. Breaker Open

b. Breaker Closed

c. Breaker Trip

2. Provide additional I/O in MVSG1 for monitoring equipment status at the 21 kV Electrical Facility. Provide I/O for monitoring the following at a minimum in addition to the I/O required for switchgear control and operations as specified.

a. North Side Transformer (XFMR N), Relay 71, Low Oil Level (LSL-U92)

b. North Side Transformer (XFMR N), Relay 63, High Pressure (PSH-U92)

c. North Side Transformer (XFMR N), Relay 49, High Temperature (TSH-U92)

d. South Side Transformer (XFMR S), Relay 71, Low Oil Level (LSL-U93)

e. South Side Transformer (XFMR S), Relay 63, High Pressure (PSH-U93)

f. South Side Transformer (XFMR S), Relay 49, High Temperature (TSH-U93)

g. Station Batteries Low Voltage (ESL-U94)

h. Station Batteries On Battery Power (YS-U94)

i. Station Batteries Trouble Alarm (XA-U94)

3. Provide Modbus TCP interface between switchgear network switch and the City SCADA for diagnostic purposes. Provide all standard diagnostic variables mapped on the Modbus TCP data stream.

4. Upon failure of internal communication network, relay, or other component, the system shall issue an alarm to the facility SCADA system via the Modbus TCP link. Switchgear normal protection operation shall remain active until condition is manually acknowledged at the system HMI and returned to normal remote monitoring operation.

G. Relay Settings and Arc Flash Protection

1. Provide all interconnection, logic, settings and configuration to implement arc flash protection sensors and relays of the transformer, feeders, and 480V busses as shown on the Drawings.

2. Configure coordinated relay settings and arc flash protection relays and relay network specified for the implemented protection directly to the breaker protection logic and circuitry.

3. Coordinate the protection scheme with the short circuit, coordination study, and arc flash studies specified under Section 16080. Provide strategy to minimize arc flash hazards at the line side of the unit substation switchgear main breakers.

3.3 ACCEPTANCE TESTING

A. After installation of this equipment the switchgear shall be tested per the manufacturer's recommendations, NETA guidelines, and the requirements of Section 16080.

B. Acceptance testing shall follow the favorably reviewed site acceptance testing protocols submitted by the Contractor.

C. The switchgear testing shall be coordinated with schedule for completion of cable terminations. The switchgear manufacturer shall provide services of factory trained personnel to certify that all connections have been made properly prior to startup and testing.

D. All additional switchgear terminal blocks, contacts, materials, programming, and logic elements required to implement the functionality specified in these Specifications shall be included at no additional cost to the City.

E. Each function regarding breaker control, metering, interlocks, trip, alarms, etc. shall be tested with the manufactures service representative present.

F. Confirm proper operation of the network communications following the favorably reviewed testing procedures for testing Modbus and Ethernet interface communications including delivery of all monitored variables to preassigned registers and confirmed at the plant SCADA system per Section 13400.

G. Following successful completion of acceptance testing of the switchgear and generator but prior to permanent connection of process loads to MVSG-1, test according to the favorably reviewed test protocol. Repeat the functional testing using new process facilities at the completion of construction. Functional testing shall include testing of each breaker operation, alarms, test abort logic, and all other features and functions of the system.

H. Testing: Perform witness testing of protective devices with utility representatives present per utility standards for confirmation of utility requirements prior to energization of new utility service. Utility witness testing shall be scheduled and coordinated by the Contractor with the utility and the construction schedule for the new service work. Testing shall follow procedures and guidelines for protective devices, relays, battery systems, and other equipment as documented in utility standard practices.

I. Care and Precautions:

1. Contractor shall be responsible for any damage to equipment or material due to improper test procedures or handling of test apparatus, and shall replace or restore to original condition any damaged equipment or material.

2. Contractor shall be completely responsible for the adequacy of safety devices, personal protective equipment, personal training, and procedures for conducting tests.

3.4 ADJUSTMENT

A. The switchgear manufacturer shall provide the services of a factory trained service coordinated with the field testing and certification as described under Section 16080. Include any necessary follow-up or punch list work, and technical instruction for the City's designated personnel. The manufacturer's service technician shall demonstrate all operational features of the installed switchgear in conformance with these specifications.

B. The switchgear manufacturer's factory service technician shall make the following test and adjustments:

1. Calibrate and test all protective relays and controls per the final version of the Coordination Study specified in Section 16080.

2. Adjust continuous thermographic monitoring sensors equipment and provide baseline thermographic analysis for all terminations.

3. Adjust and lubricate circuit breaker operating mechanisms and contacts.

3.5 CLEANING

A. Remove all rubbish and debris from inside and around the switchgear. Remove dirt, dust, or concrete spatter from the interior and exterior of the equipment using brushes, vacuum cleaner, or clean, lint-free rags. Do not use compressed air.

END OF SECTION

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SECTION 16360 – UNIT SUBSTATIONS

PART 1 GENERAL

1.1 SCOPE OF WORK

A. Furnish and install the medium voltage unit substations, medium voltage air termination compartment, accessories, and appurtenances as shown on the Drawings and as specified in these Specifications.

1.2 RELATED SECTIONS

1. Section 01612 – Seismic Design Criteria
2. Section 01614 – Wind Design Criteria
3. Section 16000 – Electrical - General Provisions
4. Section 16075 – Electrical Identification
5. Section 16080 – Electrical System Analyses and Commission Field Testing
6. Section 16121 – Medium Voltage Cables
7. Section 16122 – Fiber Optic Cables and Equipment
8. Section 16350 – Medium Voltage Switchgear
9. Section 16436 – 480 Volt Switchgear

1.3 SUBMITTALS

A. Submittals shall be made in accordance with the Section 01340 and Section 16000.

B. Submit a complete list of equipment and materials and any details required to demonstrate that the equipment will function properly as a unit. The following information shall be provided:

1. Manufacturer's descriptive and technical literature. Indicate all optional equipment being provided to achieve compliance with these Specifications.
2. System configuration with single-line diagrams. Identify devices by location, frame size, trip rating, and manufacturer type number.
3. Detailed descriptions of equipment, including weights, dimensions, foundations, foundation requirements, and installation and anchoring requirements.
4. Complete dimensional plan views indicating sizes and clearances required for equipment.
5. Bus arrangement, material, ratings and insulation details.

6. Interconnection and schematic diagrams for power and control wiring showing all conduit runs and wiring with terminal numbers for each wire. All contacts, terminal blocks and wire numbers for remote devices shall be clearly identified. Show field devices and submit internal/external wiring diagrams for the interconnected unit substation components.

7. Transformer damage curve characteristics.

8. Nameplate designations.

9. Product data sheets for unit substation type transformer. List all options and accessories furnished specifically for this project.

C. Submit copies of certified factory test reports for review.

D. Submit the results of the site test for review per Section 16080, Electrical Field Testing.

E. Equipment and component titles shown on the Drawings shall be used on all manufacturer's shop drawings and all nameplates.

F. Anchorage design calculations shall be in accordance with Section 01612 and 01614.

1.4 REFERENCE STANDARDS

A. General

1. The publications listed below form a part of this specification to the extent referenced.

2. Where a date is given for referenced standards, the edition of that date shall be used. Where no date is given for the reference standards, the latest edition available on the date of the Notice Inviting Bids shall be used.

B. American National Standards Institute (ANSI)

1. ANSI C57.12.70 – Terminals Markings and Connections for Distribution and Power Transformers.

2. ANSI/IEEE C57.12.00 – Distribution, Power, and Regulating Transformers, General Requirements for Liquid-Immersed.

3. ANSI/IEEE C57.12.80 – Terminology for Power and Distribution Transformers.

4. ANSI/IEEE C57.12.90 – Test Code for Liquid-Immersed Distribution, Power and Regulating Transformers and Guide for Short Circuit Testing of Distribution and Power Transformers.

5. ANSI/IEEE C57.109 – Guide for Liquid - Immersed Transformer Through - Fault - Current Duration.

6. ANSI/IEEE C89.1 – Audible Sound Level Test.

C. National Electrical Manufacturers Association

1. NEMA TR-1 – Transformers, Regulators, and Reactors

D. National Fire Protection Association

1. NFPA 70 – National Electrical Code

E. Factory Mutual Research Corporation (FMRC)

1. FMRC 3990 – Less or Non-Flammable Liquid Insulated Transformers

1.5 MAINTENANCE

A. Submit instruction (operation and maintenance) manuals in conformance with Section 01782. The manual shall describe the equipment in full and shall include the following major items:

1. Operating instructions and start-up procedures including receiving and installation requirements.

2. Maintenance instructions listing preventative and corrective maintenance procedures. Corrective maintenance procedures shall identify the most probable failures and the appropriate repairs. Test measurement levels shall be referenced to specific test points on the installed equipment.

3. Spare parts shall be furnished for each item of material and equipment specified. The data shall include a complete list of parts and supplies, with current unit prices and source of supply. A list and itemized price breakdown of spare parts recommended for stocking shall be furnished. The parts selected shall be those which, in the manufacturer's judgment, will be involved in the majority of maintenance problems.

4. Catalog cuts and technical manuals for all components of the system.

5. Copies of all guarantees and warranties issued for the various items of equipment, showing all dates of expiration.

6. Copies of all test results.

7. Final copies of all shop drawings, incorporating manufacturing and field changes.

B. Spare Parts and Accessories

1. Furnish the following maintenance accessories.

a. One set of three 10-ft grounding jumpers and storage bags.

2. Provide the following spare parts specified:

a. One dozen each of replaceable cover bolts, nuts and special hardware.

b. One refinishing kit for field touch-up of paint.

3. Spare parts shall be boxed or packaged for long term storage and clearly on the exterior of the package. Identify each item with manufacturers name, description and part number.

1.6 SHIPMENT

A. All shipments shall be properly crated, boxed, packed, or otherwise protected to prevent damage in transit and storage. Spare parts shall not be packaged with other material. Shipments involving sea transportation shall be crated with dry materials, shall be packed with a desiccant, shall be sprayed or treated with a fungicide or given equivalent treatment, and shall be otherwise protected to insure delivery with no fungus growth, rust, or other damage due to such transportation. Each package shall be plainly marked with the following:

1. An identifying number which also shall appear on the bill of lading and other documents relating to shipment.

2. Contract number and item number.

3. Consignee's name and address.

4. Shipping weight.

B. All equipment delivered by truck shall be capable of being unloaded from 3 sides of the truck bed with a forklift loader or from above with an overhead crane. All equipment delivered by rail shall be on flat cars. Immediately, upon delivery of a shipment, the unit substations and spare parts shall be completely covered by plastic (minimum thickness of 4 mils) to protect the equipment from moisture, unless the shipment is unloaded to an indoor location. Provide temporary circuits and/or space heaters in each section to prevent condensation for any equipment stored in unconditioned spaces.

C. Equipment shall be handled and stored in accordance with manufacturer's instructions. One (1) copy of these instructions shall be included with the equipment at time of shipment.

PART 2 PRODUCTS

2.1 GENERAL

A. The Contractor shall furnish and install unit substations as shown on the Drawings and according to these specifications. The general arrangement of the unit substations shall be maintained as near as possible to that shown on the Drawings.

B. Transformer shall be outdoor secondary unit substation type from incoming line terminals to outgoing feeder terminals.

C. Primary terminations shall be side-wall mounted for cable connections in air-filled terminal chambers.

D. Secondary terminations shall be side-wall mounted for close-coupling to low voltage switchgear or busway connections in air-filled terminal chambers as shown on the Drawings.

E. Acceptable Manufacturers: General Electric, Eaton Corporation, Square D/Schneider Electric, equal.

2.2 SUBSTATION ARRANGEMENT

A. Unit substations shall be self contained and shall consist of an incoming high voltage air terminal compartment transformer, and low voltage termination compartment. The unit substation components shall be close-coupled together, all forming an integral unit. The arrangement shall be as shown on the Drawings.

2.3 UNIT SUBSTATION TRANSFORMER

A. Transformer:

1. Type: Self-cooled, 3-phase, 60 hertz with copper windings.

2. Capacity Rating:

a. OA/FA, kVA rating as shown on the Drawings.

3. Temperature Rise: 55/65 degrees Celsius. The average winding temperature rise above ambient temperature, when tested at the base transformer rating, shall not exceed 55°C, and when tested at 112% of the base rating, shall not exceed 65°C.

4. Rated BIL Voltage:

a. 150 kV (Primary)

b. 30 kV Secondary

5. Primary: 21 kV delta

6. Provide no-load primary tap changer with rated taps for two 2-1/2 percent steps above and two 2-1/2 percent steps below rated nominal voltage.

7. Coolant: UL classified, less flammable high fire point (300 degrees Celsius), non-toxic, and biodegradable. Coolant shall be Cooper FR3; Beta Fluids; ABB BioTemp Fluid; or equal.

8. Welded radiator assembly.

9. Secondary: 480Y/277V; 4-wire (solidly grounded “Y”).

10. Nominal Impedance: ANSI Standard 5.75 percent.

11. Sound Level: 63 dB (maximum average).

12. Provide the following standard features and accessories:

a. Filter press connection with pipe cap, 1/2 inch minimum

b. Drain and filter press valve, 1/2 inch minimum, globe-type, sampling valve

c. Diagrammatic nameplate on exterior of transformer enclosure

d. Liquid-level gauge with field adjustable high liquid level alarm dry contacts for remote monitoring

e. Liquid thermometer, dial-type, 0-120 degrees Celsius scale with field adjustable high temperature alarm dry contacts for remote monitoring

f. Pressure relief valve mounted with automatic resealing-resetting operation and mechanical indicator which identifies device operation; Provide high pressure relief alarm dry contacts for remote monitoring

g. Pressure vacuum gauge, -10 psig to +10 psig scale

h. Copper-faced ground pads for number of connections as shown on the drawings

i. Lifting lugs at each corner of tank for lifting the complete transformer

j. Jacking facilities at each corner of base for jacking the complete transformer

2.4 INCOMING HIGH VOLTAGE CABLE AIR TERMINATION COMPARTMENT

A. Provide dedicated section having suitable cable terminating hardware components for terminating the incoming 21 kV (nominal) medium voltage feeders routed via the bottom of the section.

2.5 HIGH VOLTAGE TERMINATION COMPARTMENT

A. Ratings:

1. Nominal system voltage: 21 kV

2. Maximum design voltage: 27 kV

3. Impulse level (BIL): 150 kV

4. Short circuit rating: 50,000 Amps, RMS, symmetrical

B. Construction

1. Enclosure shall be provided with a full height, hinged front door equipped with rotary latches with padlockable handles. The enclosure shall be braced and vented to prevent distortion under fault conditions up to the specified short circuit rating.

2. Provide outdoor rated, non-walk-in structures with tamper resistant sheet steel or unitized monocoque construction. Externally removable bolted panel construction is not acceptable.

3. Each cubicle bay shall be supported on a heavy gauge, welded steel channel base extending around all four sides, constructed to exclude rodents, vermin, and dust. Apply a bituminous undercoating to the base and to the underside of the cubicle floor plates.

4. Roof structure shall be watertight with a continuous drip edge channel on the front. Roof shall slope to the rear for water drainage. Apply an insulating compound to the underside of the roof to prevent moisture condensation. Holes for lifting eyes shall be blind tapped.

C. Buses and Insulators

1. Bus connections shall be made with high strength, high conductivity bolts and locking hardware.

2. Bus bars for line and load side cable terminations shall be insulated.

3. Bus assembly shall be mounted on reinforced glass polyester or epoxy insulators.

4. Bus bars and joints shall be insulated where ANSI standard clearances cannot be maintained.

D. Grounding

1. Make provisions for connection of incoming and outgoing cable sheaths and for the copper grounding conductors shown on the Drawings.

2. Provide continuous ground bus extending through the entire length of the switchgear. Bus material and short circuit rating shall be equal to the main bus. The ground bus shall have at least one bolted connection to the structure in each bay.

2.6 WARNING SIGNS

A. A minimum of two warning signs shall be provided on the front of the termination enclosure two on the back. The signs shall be of red laminated plastic engraved with white letters approximately 1/2-inch high. The signs shall read “DANGER, HIGH VOLTAGE, KEEP OUT.”

2.7 NAMEPLATES

A. Provide as specified in Section 16075.

B. Rating nameplates: Provide permanent, stamped or engraved metal rating nameplates indicating manufacturers name, model number, order number, voltage, current and interrupting ratings for bus, transformer, etc.

2.8 FACTORY TESTING AND INSPECTION

A. The Contractor shall provide a 10-working-day advance notice of factory testing. City reserves the right to witness all testing for the unit substation equipment.

B. Prior to shipment, the Contractor shall test and inspect the unit substations. The tests shall verify physical configuration of assembly and workmanship, the mechanical adjustments of parts and components, and the sequencing and functional operations of the power circuit breaker control systems.

C. Shop Testing: Transformer shall receive routine tests in accordance with Table 17 of ANSI/IEEE C57.12.00/C57.12.90 in addition to other specific tests noted in this Section for the unit to be supplied. Certified test form shall contain the following testing result summary:

1. Transformer ID as shown on the Drawings, manufacturer product number, serial number, and test date.

2. Phase, frequency, and coolant type.

3. High and low voltage winding type, voltage rating, and BIL.

4. Voltage values for each of the five primary tap settings.

5. Regulation at 100%, 90%, 85%, 80%, and 75% PF.

6. Efficiency at 125%, 100%, 75%, 50%, and 25% load.

7. Insulation power factor (%), capacitance, and insulation resistance.

8. Applied voltage test.

9. Induced voltage test.

10. Routine impulse test.

11. Polarity and phase relation check on the rated voltage connection.

12. Ratio check at all tap settings.

13. No-load loss and exciting current at rated voltage.

14. Impedance voltage and load loss at rated current and frequency on the rated voltage connection.

15. Resistance measurements of all windings on the rated voltage tap.

16. Liquid testing – PF and dielectric breakdown voltage.

17. Mechanical leak test: prior to shipment, liquid-fill and pressure-test transformer for at least 8 hours at the maximum operating pressure for detecting the presence of leaks.

D. Verification of Performance: Submit test results certified by a registered professional engineer.

PART 3 EXECUTION

3.1 INSTALLATION

A. Install on concrete pad following manufacturer's instructions and layout from approved shop drawings.

B. Provide equipment anchorage to resist seismic forces as directed by the approved seismic calculations per Section 01612.

C. Manufacturer or manufacturer's representative shall inspect the equipment before start-up and certify that system has been correctly installed and prepared for start-up as specified in this section and in Section 16000.

D. Remove temporary lifting angles, lugs and shipping braces. Touch-up damaged paint finishes.

E. Make wiring interconnections between shipping splits.

F. Install bus splice plates and torque the connections.

G. Caulk seams, cracks and openings in outdoor enclosures.

H. The doors shall open and close freely. Any damage to the enclosure, components, or finish shall be repaired.

3.2 FIELD QUALITY CONTROL

A. Testing and Inspection: As specified in Section 16080.

B. Provide baseline dissolved gas and metals analysis measurements.

C. Provide baseline thermographic analysis.

D. Following installation of the unit substation, test operation and demonstrate that all components protective devices, interlock devices, and control devices function properly.

E. Adjust primary taps so that secondary voltage is within 2 percent of rated voltage.

3.3 CLEANING

A. Remove all rubbish and debris from inside and around the equipment. Remove dirt, dust, or concrete spatter from the interior and exterior of the equipment using brushes, vacuum cleaner, or clean, lint-free rags. Do not use compressed air.

B. Apply touch-up paint so that all equipment is free from gouges, scratches, or other finish blemishes that occurred during shipping or installation.

3.4 TRAINING

A. Provide the services of a factory trained field engineer for training at the Project site in accordance with Section 01758. Training shall include instructions on adjusting, servicing and maintaining the unit substation and low voltage metal enclosed integrated switchgear system switchgear assemblies. The field engineer shall be at the site as specified in these Specifications.

END OF SECTION

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SECTION 16436 – 480 VOLT SWITCHGEAR

PART 1 GENERAL

1.1 SCOPE OF WORK

A. Furnish and install the 480 Volt Switchgear as shown on the Drawings and as specified in these Specifications.

B. Provide outdoor rated, manufacturer's standard walk-in enclosure for housing the 480 Volt switchgear.

C. Include factory installed components, busing, control wiring, programmable controller, and other devices for intelligent switchgear. All necessary components shall be provided under this Contract.

D. Provide source transfer logic control panel including logic controller, graphical user display, and communications interface to provide source transfer, loadbank testing, standby power source control, and other functions as specified.

E. For new equipment, provide factory installed components, busing, control wiring, programmable controller, and other devices for intelligent switchgear monitoring and main-tie-main source transfer logic. All necessary components shall be provided under this Contract.

F. Coordinate switchgear startup and commissioning with project testing, analyses, and

G. Coordinate switchgear startup and commissioning with project testing, analyses, and protective relaying coordination study performed under Section 16080.

1.2 RELATED SECTIONS

A. Section 01612 – Seismic Design Criteria

B. Section 01614 – Wind Design Criteria

C. Section 13400 – Common Work Results for Process Instrumentation and Controls

D. Section 16000 – Common Work Results for Electrical

E. Section 16075 – Electrical Identification

F. Section 16080 – Electrical System Analyses and Commission Field Testing

G. Section 16290 – Power Measurement and Monitoring

H. Section 16360 – Unit Substations

1.3 SUBMITTALS

A. Submittals shall be in accordance with Section 01340 and Section 16000.

B. Submittals shall be organized with each section separated by indexed tabs with a table of contents clearly identifying the content of each tab designated section.

C. All submittal drawings shall be prepared on 11x17 drawing format using electronic CADD systems and printed on the supplier's title block. Each drawing shall be individually and uniquely numbered to facilitate drawing identification.

D. Equipment Submittal

1. Equipment shop drawings showing elevation and plan views, bill of materials, conduit entrance spaces, nameplate data, bus arrangement, incoming transition section details, dimensions, weight, shipping splits and metering layouts. Indicate all options, special features, and ratings. Specifically identify any deviations from the specified requirements.

2. Product data sheets and catalog numbers for circuit breakers, trip devices, auxiliary equipment including current and potential transformers and other equipment incorporated into the switchgear. List all options, trip adjustments and accessories furnished specifically for this project.

3. Itemized bill of materials for metering, protective relays, accessories and control equipment.

4. Technical details for performing the source transfer scheme. Identify all necessary hardware and software requirements. Submit details of each hardware component required for the source transfer scheme, supporting logic controller software, graphic development software, and identify where the required equipment is located (switchgear compartment or control panel).

5. Itemized list of spare parts furnished specifically for this project, including quantities, description and part numbers.

E. Functional Submittal

1. Submit following release of equipment for fabrication but prior to factory testing and shipping to the site.

2. Point to point compartment wiring diagrams for metering, relay, and control circuits. Show wire and terminal numbers.

3. Elementary control diagrams including termination points for contacts used for remote monitoring purposes. Control diagrams shall include details of internal control wiring and networking including wiring to and from integral PLC and remote mounted HMI.

4. Detailed drawings of the pre-engineered enclosure for housing the switchgear. Drawings shall be prepared to scale and indicate access doorways and panels, incoming conduit access window locations, clearances, mounting/anchoring provisions and requirements, materials of construction, and finish details.

5. Detailed drawings of the remote mounted HMI control enclosure. Include dimensioned external and internal elevations, bill of materials. Submit additional switchgear HMI details including hardware, software, graphic screens, and network interface or interconnecting wiring requirements. Include data sheets, logic development description, and I/O list for switchgear resident programmable logic controllers, remote mounted HMI, and other devices used for monitoring and implementing the specified protection strategy and source transfer logic.

6. Drawing indicating final IP addresses for each protective device, source transfer controller, power monitoring device, etc. and conform to specified City addressing requirements. Standard or generic diagrams will not be acceptable.

7. Details of the remote network communications interface. Submit network module data sheets and memory mapping. Submit device parameter list with all data variables available for remote monitoring over the network interface. List shall include variable internal name, descriptive field that fully describes the contents and use of the variable, memory address and bit size, variable type (analog, discrete, text), engineering units, and function (e.g., status, alarm, internal diagnostic, etc.). Include complete configuration instructions including addressing, register allocation, data mapping, and options.

8. Details of the specified zone selective bus protection interlocking scheme including configuration, interconnection diagram, timing requirements, and indication of coordination with the Short Circuit, Protective Coordination, and Arc Flash Studies required under Section 16080.

9. Submit details of the network interface access requirements including method for accessing equipment variables, software features, and physical hardware interface details.

10. Seismic anchoring and anchor bolt sizing calculations as required per Section 01612.

11. Wind anchoring requirements as required per Section 01614.

F. Testing Submittals

1. Submit factory tests, field tests and inspection procedures and results.

2. Submit factory tests and field tests protocols in sufficient detail to verify compliance with the specified system functions and the details of the all aspects of the source transfer logic. Testing protocols shall include verification of all system “hard” and “soft” I/O, remote communication links, graphic screens, logic interlocks, and functionality. Submit test procedures and obtain favorable review before performing any tests.

3. Procedures shall include test description, forms, and checklists to be used to control and document the required tests. Include forms for each testing phase or process with sign-off areas for the Contractor and Construction Manager. Include punch list documentation forms for documenting issues found and the correction of those issues as part of the test submittal.

4. Submit network communications factory testing procedures including procedures for testing Modbus TCP interface communications. Procedures shall include method for 100% testing of all variables associated with each device. Procedure shall include factory test forms with sign-off sheets indicating proper transmittal and receipt of each variable, properly scaled, and addressed in conformance with the manufacturer's standard documentation. Include verification of each device Modbus TCP address conforming to City standards.

5. Upon completion of each required test, document the test by submitting a copy of the signed off and completed test procedures. Testing shall not be considered complete until the signed-off test procedures have been submitted and favorably reviewed. Submittal of other test documentation including "highlighted" wiring diagrams with field technician notes are not acceptable substitutions for the formal test documentation.

6. Certified shop test reports.

7. Field test and inspection reports including full testing reports of the switchgear logic and network interface testing.

8. Submit detail and test plan for field verification of the network communications interface including verification of data receipt at the City's SCADA System HMI per Section 13400.

G. Operation and Maintenance Manuals

1. General: Submit Operation and Maintenance Manual per Section 01730 and as described below. Manuals shall be available to the City and the Engineer during testing.

2. Instruction and renewal parts books

3. Final system documentation. Itemized list of spare parts furnished specifically for this project, including quantities, description and part numbers.

4. The name, address, and phone number of the local sales representative and technical assistance for the equipment.

5. The name, address, and phone number of the local parts distributor for the equipment.

6. Complete as-built system schematics and layout drawings. Indicate "as-left" conditions of all relays and metering devices. Submit written control and operating procedures for the switchgear.

7. Complete hardcopy and electronic copies of final documentation in accordance with the Section 01720.

8. Software Maintenance Documentation: Provide a detailed description of the entire software system. Documentation shall be sufficient for software maintenance and modification of the entire software system. The following items shall be included with the software maintenance documentation:

a. System User Manuals All applicable software manuals developed by the Contractor for the application software.

b. Application/Custom Software Manuals Software maintenance information not included in the system supplier's standard manuals.

c. Software Listings and Databases Submit copies of well-annotated as-built program listings of all software developed under this Contract. Listings shall reflect the as-built condition of the logic development submitted as part of the shop drawing review process.

d. Submit all listings associated with the system generation and software configuration (e.g., system parameterization tables, build maps, disk maps, etc). Submittals shall be included for process controllers, HMI application software, LOP application software, database applications, and all other equipment where specific programs or scripts were developed for this project.

e. Submit listings of all data bases configured for and associated with the system.

f. Submit listing of all custom or modified software developed specifically for the system. Listings shall reflect any changes made after the factory acceptance test.

g. Submit final data memory maps with data sets to be transferred for each PLC and HMI, and LOP provided under this Contract.

h. Submit Machine Readable Documentation Provide two sets of as-built code on CD-ROMs, thumb drive, or other approved machine readable format for all programs developed under this Contract. The machine readable documentation shall be 100 percent compatible with the Software Listings previous defined and include all documentation files including logic and annotation files. Incorporate changes made during system testing.

1.4 REFERENCE STANDARDS

A. Switchgear and components shall be designed, built and tested in accordance with the latest revision of the following standards:

B. American National Standards Institute (ANSI):

1. ANSI/IEEE C37.13, Low – Voltage AC Power Circuit Breakers Used In Enclosures

2. ANSI C37.16 – Preferred Ratings, Related Requirements and Application Recommendations for Low Voltage Power Circuit Breakers and AC Power Circuit Protectors

3. ANSI C37.17 – Trip Devices for AC and General Purpose DC Low-Voltage Power Circuit Breakers

4. ANSI/IEEE C37.20.1 – Standard for Metal-Enclosed Low-Voltage Power Circuit Breaker Switchgear.

5. ANSI/IEEE C37.50 – Switchgear Low Voltage AC Power Circuit Breakers Used in Enclosures – Test Procedures

6. ANSI/IEEE C37.51 – Metal-Enclosed Low-Voltage AC Power Circuit Breaker Switchgear Assemblies – Conformance Test Procedures

7. ANSI C39.1 – Requirements for Electrical Analog Indicating Instruments

8. ANSI/IEEE C57.13 – Requirements for Instrument Transformers

9. ANSI/IEEE C62.41.1 – IEEE Guide on the Surges Environment in Low-Voltage (1000 V and Less) AC Power Circuits

10. ANSI/IEEE C62.41.2 – IEEE Recommended Practice on Characterization of Surges in Low-Voltage (1000 V and Less) AC Power Circuits

11. ANSI/IEEE C62.45 – Guide on Surge Testing for Equipment Connected to Low-Voltage AC Power Circuits.

C. Institute of Electrical and Electronic Engineers (IEEE)

1. IEEE C62.62-2000 – Test Specifications for Surge Protective Devices for Low Voltage AC Power Circuits.

2. IEEE C37.90.2 – 1987, Trial Use Standard Withstand Capability of Relay Systems to Radiated Electromagnetic Interference from Transceivers

D. Underwriters Laboratory (UL)

1. UL 1066 – Low Voltage AC and DC Power Circuit Breakers Used in Enclosures

2. UL 1449 3rd Edition – Surge Protective Devices

3. UL1558 – UL Standard for Safety Metal-Enclosed Low-Voltage Power Circuit Breaker Switchgear.

E. National Fire Protection Association (NFPA)

1. NFPA 70 – National Electrical Code (NEC)

F. Where UL Standards exist for components, devices and/or assemblies, such standards shall apply.

G. Where reference is made to one of the above standards, the revision in effect at the time of bid opening shall apply.

1.5 QUALITY ASSURANCE

A. The equipment furnished under this Section shall be the product of a manufacturer who has produced this same type of equipment for a period of at least 15 consecutive years.

B. Switchgear shall be designed, assembled and tested by the manufacturer of the circuit breakers used in the switchgear; or the switchgear shall be designed, assembled and tested by a switchgear integrator with the integration process certified in writing by the manufacturer of the circuit breakers used in the switchgear. The written certification shall be on corporate letterhead of the circuit breaker manufacturer; confirm that the integrator followed the circuit breaker manufacturer's specific fabrication, quality control, and testing standards; and that the manufacturer's warranty shall be in effect for all equipment installed within the switchgear by the system integrator.

C. Where reference in this specification is made to "manufacturer" it shall be understood to refer to either the manufacturer or a system integrator as applicable.

D. The switchgear equipment shall be listed or labeled by Underwriters Laboratories or other equivalent, nationally recognized independent testing laboratory for the class of service intended. A nationally recognized testing laboratory is defined as one which is approved in accordance with OSHA regulations, by the United States Secretary of Labor. Provide certification of listed equipment.

E. Switchgear shall be General Electric Co.; Eaton Corporation; Tesco Controls; Industrial Electrical Manufacturing (IEM); Meyers Power Products, Inc.; Schneider/Square D; Siemens; or equal

1.6 MAINTENANCE

A. Furnish the following maintenance accessories for each switchgear lineup provided.

1. A remote racking mechanism shall be provided to minimize risk from an arc flash. Unit shall allow remotely racking a breaker in or out up to 30 feet away from the front of the equipment.

2. Integral breaker lifting device, and operated and movable, shall be rail mounted inside the top of the enclosure aisle space. The rail system shall be affixed to every vertical section that contains a circuit breaker cubicle.

3. Manual charging handle and maintenance slow closing device for electrically operated breakers.

4. Portable trip device test set and cables.

B. Provide the following spare parts in the quantities specified:

1. One dozen each of cover bolts, cage nuts and door fasteners

2. Six quarts of touch up paint

3. 10% lens caps of each color and type provided

4. 10 pilot lamps of each size and voltage

5. 10 control power fuses of each size

6. 2 of each size of auxiliary 120V circuit breaker

7. 1 spare static trip device for each unique unit supplied under this Contract

8. One each of any network interface modules.

C. Spare parts shall be boxed or packaged for long-term storage and clearly identified on the exterior of the package. Identify each item with manufacturers name, description and part number.

1.7 MANUFACTURER'S FIELD SERVICES

A. The switchgear manufacturer shall provide the field services of a factory technician as necessary to supervise/inspect installation, test and start-up all equipment provided as part of the Contract. The work shall include all travel and living expenses in addition to the technician's time required to complete supervision of the installation, testing, start-up, and training as specified in these Specifications. All equipment required for testing, start-up, performance verification, and training shall be provided by the manufacturer's technician.

B. At a minimum the manufacture shall provide the following technician person-days for each occurrence. However, the Contractor shall provide all necessary manufacturer's field support for a complete installation, fully tested, and operational as required for a fully functioning system and as specified in the Special Conditions,16001, and 16080 under the Contract Bid Price. The minimum durations listed below do not preclude additional time that may be required to achieve all the requirements of the Contract Documents.

Description	Person-Days
Inspection	2
Installation Assist	2
Settings, Adjustments	2
Start Up and Testing	2

C. Training

1. Training shall be in accordance with Section 01758. Provide training by manufacturer's qualified representative and shall include instruction on service, operation, maintenance, diagnostics, and troubleshooting as recommended by

PART 2 PRODUCTS

2.1 RATINGS

A. Service: 480 Volts, 3 Phase, 3 Wire, 60 Hz.

B. The switchgear and protective devices shall have a fully rated, short circuit withstand rating as shown on the Drawings. Systems employing series connected ratings shall not be used. Main and feeder devices shall be coordinated for selective tripping per Section 16080.

C. The continuous current rating of the bus shall be as shown on the Drawings. The bus shall be designed to carry its rated continuous current in the specified ambient temperature without exceeding the temperature rise limits specified in ANSI Standard C37.20.1. Bus bracing shall meet or exceed the equipment short circuit rating as shown on the Drawings. Line and load bus connections to feeder devices shall be rated to carry the full continuous current of the device frame.

D. The switchgear, including devices shall be designed for continuous operation at its rated current in a 40 degree C ambient temperature.

2.2 CONSTRUCTION

A. General

1. The general arrangement of the Switchgear is shown on the Drawings.

2. Switchgear shall be ABB/General Electric, Entellisys; Eaton Corporation, Magnum DS; Eaton Corporation; Schneider/Square D, Power-Zone 4; Siemens, W3; or equal by suitable, qualified system integrator as specified herein.

B. Structure

1. Switchgear shall be completely metal enclosed and sectionalized to isolate and minimize the effects of internal short circuit currents. The structure shall consist of a framework of preformed steel channels or angles covered with bolted steel sheets. Each individual breaker/metering cell shall be completely segregated from adjacent compartments and sections by steel barriers at top, bottom, and sides with either a steel barrier or a flame retardant, track resistant molded glass reinforced polyester base barrier at the rear.

2. Breaker compartments shall be equipped with shutters to protect against contact with the energized primary disconnects when the breaker is removed from its compartment. Each individual breaker cell, metering and auxiliary compartment shall be provided with a hinged front panel door.

3. Provide side barriers between adjacent vertical structures in cable and bus compartments.

4. Provide cable supports in each vertical section. Cable compartments shall be standard depth with bending space in accordance with the NEC. Provide hinged and bolted covers on the rear of each vertical section.

5. Cubicles shown on the Drawings designated as “SPACE” shall be fully configured for future installation of circuit breaker, protective devices, and auxiliary equipment not included under this Contract. SPACE cubicles shall be fully bused, wired out, with all necessary control and power circuitry to allow insertion of new circuit breakers and protective equipment without requiring field busing or wiring modifications.

6. Provide permanently installed thermographic, infrared inspection viewports to allow thermographic imaging of terminations without exposing personnel to energized equipment. Provide two infrared windows per breaker section. Viewports shall be fully enclosed and maintain the required NEMA rating of the switchgear enclosure. Viewport lens material shall allow monitoring of termination temperature via a remotely operated heat sensor. Coordinate viewport locations with switchgear walk-in enclosure access doors and cover plates.

C. Incoming Sections

1. Where indicated on drawings provide cable termination provisions within main breaker for connection of underground cable feed. Provide bus extensions and compression lugs as required for the number and size of incoming cables as shown on the Drawings.

2. Where indicated on the Drawings provide bus duct termination provisions within main breaker for connection of overhead incoming bus duct. Provide bus extensions and hardware for incoming bus duct where shown on the Drawings.

3. Where indicated on drawings switchgear shall be closed coupled to a liquid type secondary substation transformer. Provide a transition section to facilitate the coordination to the transformer.

D. Buses

1. Main bus, riser bus, and circuit breaker connections shall be tin plated copper, with bolted connections.

2. Bus bars shall not be tapered. Bolted connections shall be made with high strength bolts and locking hardware. Furnish an insulated / isolated bus system which fully insulates the horizontal main buses and vertical riser buses in accordance with UL 1558. Sections containing 4000A or larger breakers shall have bus compartment barriers. Main bus joints shall be accessible through removable / replaceable covers. No live connections shall be accessible from the rear except the breaker load side terminals. Breaker runbacks shall be insulated.

3. Provide a continuous, 1/4 in by 2 in, plated copper ground bus extending throughout the entire length of the switchgear, equipped with lugs for external ground connections, sized for cables shown on the Drawings.

4. Bus shall be rated as shown in Drawings for continuous current carrying capacity. Bus bars shall be braced to withstand the mechanical forces exerted during a short circuit current of equal to the short circuit rating of the equipment.

5. Provide a fully weatherproofed, factory assembled outdoor enclosure.

   a. Enclosure shall have lifting plates at base of structure, hinged aisle doors with rubber gaskets and padlocking provisions, asphalt base undercoating on the exterior bottom, interior lights, 1 space heater per vertical section, a ground fault interrupter receptacle, a light switch and a space heater switch.

b. Furnish a walk-in enclosure that shall include front aisle space for breaker maintenance and inspection that extends full length of the equipment, sloping roof, rear bolted hinged doors, breaker lifting device and storage provision for hoist operating crank.

c. Furnish front doors at each end of the walk-in enclosure. The aisle access door at one end shall be the width of two adjacent sections to allow easy installation or removal of power circuits breakers from the enclosure. This doublewide opening shall have two doors that are hinged on opposite sides. One of these doors shall be equipped with a panic bar.

d. Provide hinged rear access doors with provision for padlocking.

e. All aisle front doors shall be capable of being padlocked.

f. Provide wire mesh over louvers and rodent guards.

E. Low Voltage Power Circuit Breakers

1. Circuit breakers shall be air break, low voltage, draw out type, manually or electrically operated with stored energy closing mechanism. Breakers shall be ABB/General Electric Co., “EntelliGuard”; Eaton Corporation, Magnum DS; Siemens; Schneider/Square D; or equal. Circuit breakers shall conform to ANSI standards C37.13 and C37.16.

2. Circuit breakers shall be rated to carry 100 percent of the breaker current rating continuously. Provide breakers with current ratings as indicated on Drawings. Minimum interrupting ratings shall be as shown on the Drawings for the equipment. Circuit breakers shall have true 30 cycle withstand capability equal to the breaker short time interrupting rating.

3. Circuit breakers shall be equipped with an adjustable, static overcurrent trip device with true three phase RMS sensing of sinusoidal and non sinusoidal currents. Trip units shall be ABB/General Electric Co. "Entellisys"; Siemens; Schneider/Square D; or equal.

4. Trip devices shall have as a minimum the following independent trip adjustments and functions:

a. Interchangeable rating plugs or rating switch.

b. Adjustable long time pick up.

c. Adjustable long time delay.

d. Adjustable short time pick up.

e. Adjustable short time delay and switchable i2t ramp.

f. Adjustable ground fault pick up.

g. Adjustable ground fault delay and switchable i2t ramp.

h. Trip mode indications for ground fault, overload and short circuit.

i. Adjustable instantaneous.

5. Provide arc flash energy reduction maintenance switch for all switchgear circuit breakers. Maintenance function shall act to minimize circuit breaker tripping time during equipment maintenance functions. Provide local status indication for each circuit breaker when energy reducing maintenance function is activated.

6. Circuit breaker settings shall allow either the short-time or instantaneous functions to be disabled. Provide means for re-enabling the short-time or instantaneous as part of the arc-flash energy reducing maintenance switching function.

7. Main breakers shall be provided with a following voltage protection relaying package. The relay package shall be configurable to provide an alarm and/or trip the breaker in an overvoltage, undervoltage, or phase loss.

   a. Undervoltage relay shall have a minimum pickup adjustment range from 50 to 95% of nominal in 1% increments, with a delay setting range of 0.5 to 600 seconds in increments of 0.5 seconds. Delay curves shall be user selectable fixed and inverse time curves.

   b. Overvoltage relay shall have a pickup adjustment range from 105 to 125% of nominal in 1% increments, with a delay setting range of 0.5 to 600 seconds in increments of 0.5 seconds.

   c. Phase loss relay shall have a pickup adjustment range from 8 to 50% of nominal in 1% increments, with a delay setting range of 0.5 to 600 seconds in increments of 0.5 seconds.

8. Equipment Ground Fault Protection

   a. Circuit breakers shall be provided with integral equipment protection for grounded systems. The circuit breaker shall be suitable for use on three phase, three wire circuits where the neutral is grounded but not carried through the switchboard, or on three phase, four wire systems.

   b. The ground fault system shall include a memory circuit for positive tripping action despite intermittent arcing ground faults.

   c. The ground fault system shall be residual type utilizing integral solid state ground fault tripping devices.

9. Circuit breakers shall have provisions for manually charging the closing springs by a fixed operating handle. Manual tripping and closing shall be possible using pushbutton or levers mounted on the front of the breaker.

10. Provide means for monitoring circuit breaker status. Provide auxiliary contacts (MOC) or other means such as remote device input/output mimic contacts. Closing circuits of electrically operated main and tie breakers shall be designed to prevent paralleling of sources. The status of all circuit breakers shall be available on the HMI panel and via network communications for remote monitoring by other plant systems.

11. All circuit breakers shall be electrically operated. The breaker shall be charged by a 120 VAC electric motor with cutoff switch. Electrically operated main and tie breakers shall also be provided with a mechanically operated manual trip pushbutton or lever mounted on the front of the breaker, a manual charging handle and racking position indicator. The manual close pushbutton shall be guarded by a cover to prevent inadvertent paralleling of sources with means to operate the manual close pushbutton under emergency conditions.

    a. Electrically operated breakers shall be manually operable via the switchgear HMI panel when in Manual mode. Closing operations of main and tie breakers shall be interlocked to prevent paralleling of sources. Position switches shall be used to allow closure of other breakers in the interlock scheme when a breaker is racked out to the Disconnect position.

    b. Electrically operated main and tie breakers shall be provided with position switches (TOC) with a minimum of two normally open and two normally closed contacts. A sufficient quantity of contacts shall be provided for the interlock scheme that prevents paralleling of sources, to allow indication of breaker position status on the switchgear HMI panel, and for remote monitoring of breaker position status via Ethernet Modbus TCP communications. Normally closed contacts shall break before the normally open contacts make.

    c. Breaker status shall be indicated via pilot lights mounted above each breaker.

    d. Electrically operated main and tie breakers shall be provided with provisions that shall prevent closing of the breaker and place it in a trip-free condition following a trip until the device has been manually reset. Network interlocks or bell alarms with lockouts and associated remote reset switches are acceptable.

12. Circuit breakers shall be capable of being moved from the connected to disconnected position with the front door closed. Draw out mechanism shall provide four distinct positions for circuit breaker: connect, test, disconnect, and withdrawn. An indicator shall be provided on the front of the breaker to show position of circuit breaker. Interlocks shall be provided to prevent the following operations:

    a. Racking a closed breaker into or out of the CONNECTED and TEST positions.

    b. Closing a circuit breaker until it is fully racked into the TEST or CONNECTED position.

    c. Withdrawing a circuit breaker from the cubicle while the closing springs are charged.

    d. Insertion of a breaker of incorrect frame size or inadequate interrupting capacity.

13. Each breaker shall have a secondary control power plug, which automatically engages a cell mounted mating receptacle in the CONNECTED position and disengages as the circuit breaker is racked out to DISCONNECT position. The primary disconnects shall be parted and the control power plug shall remain engaged when the breaker is in the TEST position.

14. Circuit breaker frame sizes and trip ratings shall be shown on the Drawings.

15. Cell for future breakers shall be fully equipped with draw out carriage, racking mechanism, primary and secondary contacts, and current transformers.

F. Secondary Wiring and Control Devices

1. Wiring: 600 Volt, stranded copper, type SIS, flameproof switchboard wire, minimum size No. 14 AWG for control, No. 14 AWG for power and instrument transformer secondaries. Wiring shall be grouped together with harnesses or in ducts and shall be secured to the structure. Pull out or bayonet type fuse holders shall be used for control circuits.

2. Identification and termination: Ring type, crimp on wire lugs with sleeve type wire markers at each termination point labeled with origin/destination points. Terminal blocks shall be rated 20 Amps minimum, 600 Volt, screw type with white marking area.

3. Provide short circuit type terminal blocks for all current transformer secondary circuits and test terminals. Units shall have integral and automatic short circuiting when disconnecting link is exercised. There shall be no undefined intermediate positions.

4. Instrument and control switches:

   a. 600 Volt switchboard rotary type, rated 20 Amps continuous, with black molded Phenolic escutcheon plates, white characters, ABB/General Electric, Type SB 1 or equal. Provide where required: switch functionality may be replaced by HMI interface if preferred by the manufacturer.

   b. Circuit breaker control switches shall be of the momentary contact, spring return type having mechanical target or flag and a black, fixed, pistol grip handle.

5. Indicator lights: Provide pilot lights at each circuit breaker for OPEN/CLOSED indication and control power status indication. All pilot lights shall be LED type.

6. Provide all circuit breakers and enclosures fully wired out to terminal strips for zone interlocking, maintenance switching, or other control interlocking functions provided under this Contract and for future use by the City.

G. Control and Metering Transformers

1. All instrument transformers shall be UL listed and classified as indicated in Drawings.

2. Potential transformers shall be provided where indicated on Drawings or where required to properly implement the metering and protection scheme specified. Provide potential transformers with burden and accuracy to support connected meters and relays as required by ANSI/IEEE C57.13.

3. Current transformers: Current Transformers shall be as shown on Drawings or where required to properly implement the metering and protection scheme specified in these Specifications. Provide current transformers with burden and accuracy to support connected meters and relays as required by ANSI/IEEE C57.13. If 3-phase current transformers are used, provide CT assembly with a color-coded secondary harness terminating in a polarized plug connector.

4. Control power transformers: Two winding dry type with primary fuses, secondary circuit breaker, NEMA sized for the application. Provide on each incoming source breaker.

5. The CPT circuit shall contain an ANSI 83 function for CPT automatic transfer. At least two control power sources shall be used with an automatic control power throw over to supply power to a redundant UPS system that shall in turn provide control power to all electronic devices and breaker controls (with the exception of circuit breaker closing spring charging motors) contained in the switchgear. The control power system (UPS) shall provide a minimum of 30 minutes of continuous control power to all electronic devices during loss of source power.

H. Surge Protection Device (SPD)

1. General:

a. Provide SPD device on the switchgear. SPD shall be mounted integral to the LV switchgear and shall not violate the equipment manufacturer's UL label.

2. Electrical Requirements

a. Provide SPD with maximum surge current rating based on testing of a complete SPD unit including fuses and all components that make up the SPD system. Devices that derive a maximum surge current rating by adding test results of individual components are not acceptable.

b. The SPD device repetitive surge current capacity shall be tested utilizing a 1.2x50 microsecond, 20kV open circuit voltage, 8x20 microsecond, 10kA short circuit Category C3 test waveform, per ANSI/IEEE C62.41 and ANSI/IEEE C62.45 at one minute intervals. A failure is defined as either performance degradation or more than 10% deviation of clamping voltage at the specified surge current.

c. Maximum surge current shall be at least 125kA per mode and repetitive surge current ratings shall be 20,000 C3 impulses minimum. Provide a SPD with higher maximum surge current ratings if necessary to meet this requirement.

d. The UL 1449 Nominal Discharge Current Rating (In) shall be 20kA.

e. The Voltage Protection Rating (VPR) shall be tested in accordance with UL-1449. Where an integral disconnect is provided, the SPD VPR shall be determined with the integral disconnect. The VPR values shall not exceed 1200 line to neutral, 1200 neutral to ground, 1200 line to ground, and 2000 line to line on a 277/480V grounded Wye system.

f. The SPD shall be UL witness tested to a fault current rating equal to or greater than the fault current rating of the distribution equipment. The SPD fault current rating shall be marked on the SPD in accordance with the requirements of UL1449.

g. The use of electronic grade MOV's is not acceptable. Systems using gas tubes, silicon avalanche diodes, selenium rectifiers, or printed circuit board technology in surge current path are not acceptable.

h. The maximum Continuous Operating Voltage (MCOV) shall be 115% of nominal on 480/277 volt systems and 125% of nominal on 240-208/120 volt systems.

i. The fusing system shall be capable of allowing the rated maximum surge current to pass through without fuse operation. Systems utilizing a fusing system that opens below the maximum surge current level are unacceptable. The fusing system shall use thermal fuses and surge rated fuses, which shall be included in the surge current testing.

j. SPDs shall include integral fusing for each suppression component. Designs that rely solely on an electrical panel’s main breaker to interrupt fault currents resulting from a shorted suppression component are not acceptable.

k. SPD shall have an integral non-fused disconnect, tested to the maximum surge current rating of the device.

3. Control and Monitoring:

a. Operational status indicating lights.

b. Audible alarm and alarm indicating light and test switch, enabled via a front panel pushbutton switch.

c. Dry contacts for remote monitoring purposes, 1NO & 1NC contact. Change in state on MOV failure.

d. Transient voltage surge counter with battery backup.

4. Manufacturer:

a. Provide ABB/General Electric Co, Eaton Corporation, Tranquell HE; Square D; or equal.

2.3 SWITCHGEAR INSTRUMENTATION

A. Provide Breaker Metering and Monitoring for display on the switchgear HMI with export capability to the facility SCADA historian as shown on the Contract Documents.

B. Provide power metering per Section 16290 where shown on the Drawings.

2.4 SWITCHGEAR REMOTE MONITORING AND SOURCE TRANSFER CONTROL SYSTEM

A. Discrete Input/Output (I/O) Interface

1. Provide controller input/output (I/O) devices incorporated into the Switchgear with minimum combination of 64 analog and discrete points. I/O interface shall be used for implementing the specified source transfer control, protection, and status monitoring schemes.

2. The total number of digital input and output points shall be determined by the switchgear supplier to implement the protection and status monitoring schemes as described in these Specifications plus a minimum of 20% spare points of each type provided.

B. Human Machine Interface (HMI)

1. Provide remote control and monitoring capability for switchgear equipment, circuit breakers, electronic devices and other critical components as specified. Provide one HMI and control system for monitoring and controlling the 480V switchgear. Provide ABB/General Electric Entellisys HMI; Eaton; Siemens; Schneider/Square D; or equal.

2. The HMI color view screen will be backlit liquid crystal display (LCD) and have a minimum diagonal viewing area of at least 15 inches.

3. The HMI shall contain: a frame integral keyboard used for the direct input of alphanumeric data and two USB ports located at the front to provide connection of USB-based devices.

4. The HMI shall be provided with operating system and software to display the following screens. These screens shall be originally configured in the factory and shall be finalized during the factory startup/commissioning process. As a minimum the following screens, or functional equivalents, shall be incorporated into the HMI for end customer use:

a. Main Menu Screen – Displaying choices of “ONE-LINE”, “ELEVATION”, “SEQUENCE OF EVENTS”, “SYSTEM HEALTH”, “USER SETTINGS”, “USER ADMINISTRATION”, MAINTENANCE”.

b. Active One-Line Diagram – Displaying all the circuit breakers contained in the lineup and their active status as OPEN, CLOSED or TRIPPED. Active metering values for bus voltage for each phase and breaker current for each phase shall also be displayed. Touching a breaker symbol on the one-line diagram shall take the user to a screen containing metering data and status information for the particular breaker.

c. Physical Front Elevation Diagram – Displaying the general appearance and mechanical layout of the lineup. Touching a breaker cubicle on the elevation shall take the user to a screen containing metering data and status information for the particular breaker.

d. Sequence of Events Menu – This display will contain all the recorded events pertinent to the line-up (breaker events, alarm events, system events, etc.). These events will all be time stamped and all system events for the entire lineup shall be synchronized. The user shall be able to configure the preferences of events (FIFO, Auto Cleanup, etc.) and shall be able to filter the information shown.

e. System Heath Menu – This display will provide status indication of the central processors and individual circuit breaker electronics.

f. User Settings Menu – This display will allow the operator to view the configuration of the system and the individual settings associated with each breaker.

g. In addition to the General Menus and Diagrams listed above, the following screens shall be available for each individual breaker in the lineup. Breaker Status showing breaker contact position, closing spring status and breaker position as well as protection settings showing enabled, disabled, etc. Detailed metering showing all the configured parameters.

h. Provide additional HMI screens for monitoring, control, and configuration of source transfer controls per specified transfer requirements.

i. The HMI shall display the one second duration capture for all current and voltage channels. The waveform data shall be exportable using industry standard, open data formats (CSV, XLS, or similar) for compatibility with electrical power analysis packages.

j. The HMI shall display the logged demand information in a line graph with time as the horizontal axis and the demand values as the vertical axis.

k. The HMI shall display the K Factor value by phase, the current total harmonic distortion by phase and the voltage total harmonic distortion by phase. Additionally, by selecting the “Harmonic Analysis” button, the user shall view the frequency spectra for the voltages and currents captured on the system. This information shall be displayed in a bar graph with the harmonic number as the horizontal axis and the ampere value on the vertical axis. A table shall also be displayed showing the individual magnitude value under each harmonic number for each phase.

l. Provide an additional six screen for monitoring and operations as directed by the City. Details of these additional screens shall be provided during startup and commissioning of the equipment.

m. Provide common indicators for the following conditions on all screens:

1) AUTO Mode: The AUTO indicator shall be off if the system cannot execute an auto transfer.

2) MANUAL Mode: The MANUAL indicator shall be on if the system MODE Selector switch in the MANUAL position.

3) Indicator if the system is in isolation (solely on the standby source)

4) Indicator if system has executed an automated transfer to standby

5) Normal Utility Source Available

6) Standby Source Gen-2 Available

7) Utility Main Breaker Failed

8) Bus Tie Breaker Failed

9) Generator Main Breaker Failed

5. Provide one HMI device and all necessary PLCs, network switches, and UPSs located in a stand-alone enclosure located in the switchgear walk-in enclosure. HMI control shall allow remote user operation and maintenance of components outside the switchgear arc flash boundary as determined under Section 16080..

6. Contract Documents are based on Ethernet Modbus TCP network connectivity between switchgear and HMI/Autotransfer control panel as shown on the Drawing. If alternate networks or individual hardwired connections are required to implement the control and metering functionality specified in these Specifications, provide all necessary additional conduit, wire, terminations, specialty terminations, testing, and other appurtenances and services for a fully functioning, fully tested system all at no additional cost to the City.

7. Provide additional, dedicated configured Ethernet port for remote communication of equipment monitored variables using Ethernet Modbus TCP to City SCADA system as shown on the Instrumentation Drawings and specified in Section 13400. Coordinate equipment IP addresses with City Ethernet addressing requirements as specified.

8. Provide integral interface to a laptop computer for configuration, diagnostics, and troubleshooting of the Switchgear.

9. Provide status monitoring of circuit breaker Open, Close, and Trip for all switchgear main, tie, and feeder breakers provided under this Contract for remote monitoring by the existing plant SCADA system via Ethernet/Modbus TCP communications. If hardwired connections methods are used, provide conduits, wires, IOs, and associated devices as required.

2.5 PANEL MOUNTED (INDUSTRIAL GRADE) ETHERNET SWITCHES

A. Provide industry-standard ultra wide IEEE 802.3u 100Base-TX and 100Base-FX autosensing Ethernet switches supporting Fast Ethernet communications over both fiber optic (FO) and copper cables. Provide managed Ethernet switches with a minimum of sixteen 100Base-TX ports and two 100Base-FX ports

B. FO ports shall be single-mode type with type ST connectors.

C. Switch shall be standard DIN rail mount type for industrial application having a minimum operating temperature of 60 degree C, and listed for installation in a UL508 control panel.

D. Switches shall include an alarm relay contact output rated for 1 amp at 24VDC.

E. Managed switches shall be Moxa EDS-500, N-Tron, or approved equal.

2.6 AUXILIARY POWER

A. Provide auxiliary power 120VAC panelboard for serving Switchgear D auxiliary loads including control power, space heaters, ventilation fans, and other equipment as specified or as required by the manufacturer. Provide lighting panel per Section 16441 and as shown on the Drawings.

B. Provide auxiliary fuse protection, control power transformers, and manual transfer switch to allow switching of the auxiliary panelboard to alternate buses as shown on the Drawings.

2.7 MARKING AND IDENTIFICATION

A. Provide per Section 16075.

B. Provide permanent master nameplate for switchgear designation, manufacturer's name, model number, order number and voltage, current and interrupting ratings.

C. Provide warning signs marked "DANGER 480 VOLTS KEEP OUT" on each rear compartment door. Signs shall be adhesive backed Mylar, OSHA approved.

D. Provide arc flash analysis and labeling per Section 16080.

2.8 HMI ENCLOSURE

A. Provide standalone NEMA 12 HMI enclosure mounted separately from the switchgear lineups but within the switchgear walk-in enclosure. Provide all necessary gateways, cabling, terminations for cabling connections installed in the conduits shown on the Drawings.

2.9 SURFACE PREPARATION AND SHOP COATINGS

A. All non-current carrying metal parts of the switchgear assembly shall be cleaned of all weld spatter and other foreign material and given a hot iron phosphate chemical treatment. A zinc rich, heat cured, epoxy primer shall be applied to inhibit rust.

B. Equipment shall be finish painted with one coat of manufacturers standard air dried enamel.

C. Unpainted circuit breaker parts shall receive a protective zinc plating to prevent corrosion. All device contacts shall be gold or silver plated.

2.10 FACTORY TESTING

A. Perform manufacturers standard production testing and inspection in accordance with ANSI standards. In addition perform additional testing as specified below to ensure proper functioning of logic and protection features specified.

B. At a minimum perform the following production tests on the assembled switchboard:

1. Device check – visual inspection of device catalog number to verify compliance to specification.

2. Control lead check – continuity test to ensure correctness of all wiring.

3. Instrument transformer ground test – verify that instrument transformer frame is grounded.

4. Meter and relay check – induce current on the secondary side of current and voltage transformers to verify device functionality.

5. Control power check – apply power to control circuits.

6. Bus check – visual check of phase, neutral, and ground buses in accordance with switchboard one-line diagram.

7. Clearance check – inspect buses and devices for proper electrical clearances.

8. Connection test – check tightness of all bolted connections.

9. Nameplate check – verify nameplate engraving and location are per drawings.

10. Current and voltage transformer polarity check – visually inspect transformer polarities are in accordance with drawings.

11. Proper commissioning of all protective relays and functions in accordance with the manufacturer's standard testing procedures.

12. Proper functioning of status monitoring and control at the HMI interface. All system I/O shall be verified using a point-to-point circuit to HMI graphic screen protocol.

13. Proper functioning of the source transfer scheme and anti-paralleling interlocks

14. Power management communication test – verify all devices are able to communicate on the switchboard communication bus.

15. Perform factory testing of the network interface confirming the network data highway operability including verification of all data mapping variables as documented in the Contractor's submittals. Testing shall confirm proper delivery of all monitored variables using the network protocol as shown on the Contract Documents,

C. The City reserves the right to attend the factory testing at the switchgear manufacturer's facility. Provide a minimum of 4 weeks advance notice to the City of the scheduled test. Testing shall only be scheduled following favorable review of the submitted factory test protocol. All factory tests shall follow the favorably reviewed test protocol.

D. Factory certified test reports shall be issued at the conclusion of the factory testing. Submit certified copies of test results to indicate proof of compliance with ANSI C37.50 and C37.51.

PART 3 EXECUTION

3.1 INSTALLATION

A. The equipment shall be leveled and anchored directly to a concrete equipment pad or finished floor as shown on the Drawings. Provide hardware and metal shims for installation. Grout and caulk all voids beneath the equipment base. Anchor bolts shall in conformance with seismic requirements of Section 01612 and Wind Loading requirements of Section 01614. Anchoring requirements shall apply to both switchgear structure and walk-in enclosure.

B. Install the equipment in accordance with the manufacturers' instructions.

C. Remove temporary lifting angles, lugs, and shipping braces. Touch up damaged paint finishes.

D. Make wiring interconnections between shipping splits.

E. Install bus splice plates and torque the connections.

3.2 SYSTEM CONFIGURATION

A. General: Perform all system programming and graphical display development of the switchgear remote operating and monitoring system. Provide all logic and graphic displays for protection scheme as specified and shown on the Drawings.

1. Provide all logic and graphic displays for automatic isolation of the switchgear from the plant distribution system upon failure of the primary sources and connection to the standby generator source.

2. Provide all logic and graphic displays for the source transfer and isolation to allow mains and tie breaker operation to automatically transfer source power and transfer back to utility power.

3. Provide all protective overcurrent relay settings and interlocks as required per the electrical system studies performed under Section 16080.

B. The HMI shall provide the following touchscreen operable system selector switches.

1. MANUAL operation of each breaker in the lineup

2. The control screen shall include the following indicators

a. Simplified system 1-Line diagram showing status of all monitored system components.

b. MANUAL Mode

c. Alarm indicator if the system is in isolation; provide logic for alarm on execution of automated transfer

d. Alarm: Indicates a fault or other problem with the switchgear logic and control system

e. Utility Main Source Available

f. Generator Source Available

g. Utility Source Breaker Failed

h. Tie Breaker Failed

i. Generator Source Breaker Failed

3. Select AUTO MODE – Source Transfer Operation

a. HMI automated controls for the main and bus tie breakers are active when the transfer system control selector is in the AUTO position. Manual operation of any of these breakers through either the HMI controls or the manual pushbuttons, panel selector switches, or pushbuttons on the breaker enclosure escutcheon shall switch the transfer control from AUTO mode to MANUAL mode and the condition logged on the system Event Log.

4. Select MANUAL OPERATE Mode:

a. Breakers shall be able to be manually opened and closed by HMI operator commands.

b. Provide Switchgear electronic interlocking to ensure against more than one main and tie breakers from being closed at the same time. During normal operation, at no time shall parallel operation of generators with utility be allowed.

C. Zone Selective Interlocking

1. Provide all interconnection, logic, settings and configuration to implement zone selective interlocking bus protection. Provide zone selective interlocking between main breaker, tie breaker, and feeder breakers. The interlocking scheme shall act to allow breaker to breaker communication for fault identification and clearing in the minimum possible time regardless of the location of the fault.

2. Coordinate the zone selective interlocking scheme with the short circuit, coordination study, and arc flash studies specified under Section 16080. Provide strategy to minimize arc flash hazards at the load side of the switchgear main breakers.

3. Provide zone selective interlocking for all installed breakers with logic developed and wiring installed for any breakers shown as future on the Drawings.

D. Source Transfer Controls

1. Provide all logic and graphic displays for implementation of the two source transfer scheme as described below. Provide source transfer system in the switchgear including instrumentation, logical controller, and Human Machine Interface (HMI) Computer.

2. Provide monitoring and interlocking as noted for source transfer scheme based on status of breakers. Provide I/O interfaces for remote monitoring as required by the Contract Documents.

3. Provide monitoring and interlocking as noted for source transfer scheme based on status of breakers.

4. Provide a two (main breaker) circuit breaker automatic throwover scheme with all necessary voltage sensing instrumentation, status and position sensing devices, control devices, control power requirements, etc. The interface for the status indication of the appropriate circuit breakers and the control of these devices (Automatic Transfer, Manual Mode, Test Mode, etc.) shall be accomplished via the equipment lineup touch screen HMI.

5. Transfer logic shall be executed upon utility system failure. Generator (GEN-2) source feeder energization shall cause source transfer to be executed and shall not result in source transfer back to Normal mode. Normal mode shall only retransfer upon re-establishment of utility power and manual command by operations or maintenance staff at the system HMI.

6. Voltage sensing on each source shall be three phase with loss of phase protection. All transfer scheme logic shall be incorporated into and executed by the switchgear controller. The system shall receive the following inputs: source voltage status, breaker status (open, closed, tripped on fault) for each main (total of two) and bus tie breakers, status of main utility breaker and EGEN-2 breaker.

7. The HMI shall show local indication of the following: transfer scheme status (Auto/ Manual) and control fault.

8. Controller shall be powered from the redundant UPS or battery based control power source system supplied with the switchgear to ride through any momentary switching of control power sources.

9. Basic automatic throwover control logic features shall include: interlocking of the main and bus tie breakers in an open transition scheme to prevent paralleling sources; time delay for initiating a transfer upon an over/undervoltage or loss of phase condition; time delay for return to normal after the over/undervoltage or loss of phase has been corrected.

3.3 FIELD TESTING

A. Install the lineup at the site in conformance with the manufacturer's requirements.

B. Following installation, the manufacturer shall provide startup/commissioning by a factory-trained start-up service engineer(s). The manufacturer's recommended field service tasks shall be performed per the requirements of Sections 16001 and 16080.

C. In the event of an equipment fault, notify the Engineer immediately. After the cause of the fault has been identified and corrected, a joint inspection of the equipment shall be conducted by the Contractor, the Engineer and the equipment manufacturer's factory service technician. Repair or replace the equipment as directed by the Engineer prior to placing the equipment back into service.

D. Perform full testing and commissioning of system monitoring, remote breaker operation, breaker interlocking logic, and all other HMI functionality specified.

E. Following successful completion of acceptance testing of the switchgear and generator (GEN-2) but prior to permanent connection of process loads, test the source transfer system according to the favorably reviewed test protocol. Perform functional testing using portable load banks provided for this purpose. Repeat the functional testing using new process facilities at the completion of construction. Functional testing shall include testing of the entire source transfer scheme using “live” power switching to positively simulate utility outages, generator starting, breaker transfer, manual overrides, alarms, test abort logic, and all other features and functions of the source transfer system.

F. Confirm proper operation of the network communications following the favorably reviewed testing procedures for testing the network interface communications including delivery of all monitored variables to preassigned registers and confirmed at the plant SCADA system per Section 13400.

3.4 ADJUSTMENT

A. Startup/commissioning shall include adjusting and lubricating circuit breaker operating mechanisms and contacts in accordance with manufacturer’s recommendations.

B. As part of the manufacturer-provided start-up services, the manufacturer’s service engineer shall set all adjustable protective devices to the values recommend in the coordination study per Section 16080.

C. Verify operation of all circuit breakers prior to the switchgear operating under load. Testing shall be in accordance with Section 16080.

3.5 CLEANING

A. Remove all rubbish and debris from inside and around the switchgear. Remove dirt, dust, or concrete spatter from the interior and exterior of the equipment using brushes, vacuum cleaner, or clean, lint free rags. Do not use compressed air.

3.6 TRAINING

A. Provide the services of a factory trained field engineer for training at the Rinconada Project site in accordance with Section 01758. Training shall include instructions on adjusting, servicing and maintaining the low voltage metal enclosed integrated switchgear system switchgear assemblies. The field engineer shall be at the site as specified in these Specifications.

END OF SECTION

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SECTION 16440 – SWITCHBOARDS

PART 1 GENERAL

1.1 DESCRIPTION

A. Work included:

1. Furnish, install and test the switchboards as shown on the Drawings in accordance with these Specifications.

2. Switchboards shall be sized to include all equipment, spares and spaces as shown on the Drawings.

3. The Contractor shall coordinate the size of the switchboard foot print with the size of the equipment pad.

4. The Contractor shall provide anchorage calculations as specified herein.

5. Where existing switchboards are shown as being modified or retrofitted under this Contract, provide original manufacturer approved components suitable for the application shown. Modifications or retrofits shall not alter the UL labeling of the original switchboard. Existing switchboards modified under this Contract include:

   a. DPB1: GE Spectra Series. Req No. 47750024-DP. Job No. 17869860-5

   b. DPB2: GE Spectra Series. Req No. 47750024-B2. Job No. 17871472-1

   c. DPC1: GE Spectra Series. Req No. 47750024-DP. Job No. 17869860-7

B. Related sections:

1. Section 01612 – Seismic Design Criteria

2. Section 16000 – Common Work Results for Electrical

3. Section 16080 – Electrical System Analysis and Acceptance Testing

1.2 QUALITY ASSURANCE

A. The switchboards shall be the product of a manufacturer who shall also be the manufacturer of all the circuit breakers and fused switches included in the switchboards.

B. All units and sections shall be UL labeled. Switchboards containing service entrance equipment shall be UL labeled "Suitable for Use as Service Equipment".

1.3 SUBMITTALS

A. Submit shop drawings and product data in accordance with Section 01340.

B. The Contractor shall furnish submittals for approval as outlined below:

1. Manufacture's equipment shop drawings showing elevation, dimensions and plan views including anchorage pattern. The drawings shall show compartment arrangement, weight, and shipping splits.

2. Single line diagrams, point-to-point compartment wiring diagrams for metering, relay, and control circuits. Show wire and terminal numbers.

3. Bus material, ratings, and insulation details.

4. NEMA rating of enclosure.

5. Product data sheets and catalog numbers for circuit breakers and fused switches. List all options, trip adjustments, and accessories furnished specifically for this project. Submit time current characteristic curves for each protective device provided.

6. Itemized bill of material for metering, protective relays, accessories, and control equipment.

C. Submit anchoring calculations for the actual equipment being provided per the requirements of Section 01612.

1.4 DELIVERY, STORAGE, AND HANDLING

A. Refer to Section 16000.

1.5 REFERENCE STANDARDS

A. The switchboards shall be designed, built, and tested in accordance with the latest editions and revisions NEMA Standard PB-2, and Underwriters' Laboratories (UL) Standard No. UL-891. Switchboards shall also comply with any applicable ANSI and IEEE Standards and the requirements of the National Electric Code (NEC).

B. UL 489, Molded Case Circuit Breakers

C. Where reference is made to one of the above standards, the revision in effect at the time of bid opening shall apply.

1.6 SPARE PARTS

1. Provide the following spare parts in the quantities specified for the switchboards:

a. One dozen each size of cover bolts, cage nuts and door fasteners.

b. Six cans of aerosol touch-up paint.

c. 50 percent replacement fuses, all types and sizes.

d. Two of each color replacement lens caps for pilot lights.

2. Spare parts shall be boxed or packaged for long term storage. Identify each item with manufacturers name, description, and part number on the exterior of the package.

1.7 MANUFACTURER'S FIELD SERVICES

A. Installation.

1. Manufacturer's representative shall be present at the site for a minimum of 4 hours for assistance, startup, testing and certification. Travel time not included.

2. Submit a manufacturer's certificate of proper installation upon successful completion of the field testing and startup.

B. Testing.

1. The manufacturer's service technician shall provide calibration, inspection, and adjustments.

PART 2 PRODUCTS

2.1 GENERAL

A. The switchboard shall be front accessible deadfront type and shall have individually mounted main breakers with group mounted feeder breakers. The switchboard shall be a fully integrated system that provides distributed power as shown on the single line diagrams.

B. The switchboard and components shall be of the same manufacturer.

C. Feeder devices 1200A and smaller shall be arranged in group mounted construction. Mounting for the group mounted circuit breakers shall be by bolted connections. Feeder devices rated greater than 1200A shall be individually mounted. Feeder section(s) shall be isolated from main section, and from adjacent feeder sections.

D. Isolated compartments shall be provided for main circuit breaker device and metering equipment.

E. A cable pull section shall be furnished where shown on the Drawings.

F. The switchboard shall be service entrance rated as noted on the Drawings.

2.2 SWITCHBOARD

A. Ratings.

1. Service: 480V, 3 phase, 3 wire. Bus ratings shall be as shown on the Drawings.

2. The switchboards and protective devices shall be fully rated for a short circuit current of 65,000 RMS symmetrical amperes or as shown on the Drawings, whichever is greater.

3. Systems employing series connected ratings shall not be used.

4. The manufacturer shall design the switchboard, including devices, for continuous operation at its rated current in a 40° C ambient temperature.

5. Switchboards shall be UL listed.

B. Construction.

1. Switchboard shall consist of the required number of vertical sections bolted together to form a rigid assembly. The sides and rear shall be covered with removable bolt-on covers. All edges of front covers or hinged front panels shall be formed. Provide adequate ventilation within the enclosure.

2. Side, top and rear covers shall be code gauge steel, bolted to 12-gauge frame structure members. Front doors shall be flush, hinged, with screw fasteners.

3. Switchboard Service Entrance sections shall comply with UL Service Entrance requirements including a UL service entrance label, incoming line isolation barriers, neutral disconnecting link, and a main bonding jumper that bonds the neutral bus to the switchboard ground bus for solidly grounded wye systems.

4. All metal surfaces shall be chemically cleaned and primed. The finishing coat of paint shall be ANSI Z55.1 No. 61, light gray enamel.

5. NEMA 1 type switchboards shall be indoor type, free standing, front accessible, front and rear aligned and suitable for against-the-wall mounting. Side access shall not be required. All connections and bus maintenance shall be from the front or the top.

6. Incoming Section

a. Incoming section shall be cable connection to main breaker.

b. Furnish switchboard(s) arranged for bottom entry of incoming cable.

c. Provide mechanical lugs in the quantity and size required per the Contract Drawings. All lugs shall be tin-plated aluminum and UL listed for use with copper cable. Lugs shall be rated for 75°C.

C. Buses

1. All buses shall be tin-plated copper. The bus bars shall have sufficient cross sectional area and separation to meet UL 891 temperature rise and insulation requirements.

2. Buses shall be braced for the specified equipment short circuit current rating, but in no case less than 65KA RMS symmetrical.

3. All bus joints shall be connected with high tensile steel bolts and conical spring-type or Belleville washers.

4. Provide a copper ground bus sized to meet UL 891 extending throughout the entire length of the switchboard, equipped with lugs for external ground connections, sized for cables shown on the Drawings.

5. Unused spaces, or spaces indicated for future devices shall include doors, bus, device supports or mounting plates and connections.

6. Main horizontal bus bars shall be standard tapered per UL.

D. Manufacturers:

1. General Electric, Spectra Series.

2. Eaton Cutler-Hammer, Pow-R-Line C.

3. Schneider/Square D

4. Approved equal.

2.3 COMPONENTS

A. Circuit Protective Devices

1. Device trip setting and frame rating shall be as shown on the Drawings.

2. Main circuit breaker shall be individually mounted, insulated case circuit breaker for ratings 1200A and greater or individually mounted molded case circuit breaker for ratings 1000A and less. Provide device as specified in appropriate article below., Circuit breakers shall be listed to UL489, 3 Pole, 600 Volt, 100 percent rated, bolt-on type with electronic trip device. Provide with ground fault protection for services greater than 1000A per NEC. Interrupting RMS symmetrical ampere rating shall at minimum be 65 kAIC. Provide breaker digital electronic trip units as specified.

3. Feeder devices below 1200 amps shall be group mount molded case circuit breakers with bolted connections. Feeder devices 1200A and larger shall be individually mounted insulated case circuit breakers. Provide devices as specified in appropriate article below. Interrupting RMS symmetrical ampere rating shall be a minimum 50 kAIC.

4. Insulated case circuit breakers

a. Insulated case circuit breakers shall be individually mounted.

b. Main and tie breakers shall be manually operated, stationary mounted.

c. Breakers shall be constructed of a high dielectric strength, glass reinforced insulating case. The interrupting mechanism shall be arc chutes. Steel vent grids shall be used to suppress arcs and cool vented gases. Interphase barriers shall isolate completely each pole.

d. Breakers shall contain a true two-step stored energy operating mechanism which shall provide quick make, quick break operation with a maximum five cycle closing time. Breakers shall be trip free at all times. Common tripping of all poles shall be standard.

e. Insulated Case circuit breakers shall be rated to carry 100 percent of their frame ampacity continuously.

f. A charging handle, close push-button, open push-button, and Off/On/Charge indicator shall be located on the breaker escutcheon and shall be visible with the breaker compartment door closed.

5. Molded case circuit breakers

a. Group mounted breakers shall be connected to the vertical bus by bolted connections.

b. Individually mounted molded case circuit breakers shall be stationary mounted.

c. Circuit breaker frames shall be constructed of a high-strength, molded, glass-reinforced polyester case and cover. Breakers shall have an over-center, toggle handle-operated, trip free mechanism with quick make, quick break action independent of the speed of the toggle handle operation. The design shall provide common tripping of all poles. Breakers shall be suitable for reverse feeding.

d. Breakers shall have ON and OFF position clearly marked on escutcheon. Breakers shall include a trip-to-test means on the escutcheon for manually tripping the breaker and exercising the mechanism and trip latch.

e. Breakers shall include factory installed mechanical lugs. Lugs shall be UL listed and rated 75 or 60/75 degrees C as appropriate.

f. Breakers larger than 150 amps shall use digital true RMS sensing trip units and a rating plug to determine the breaker trip rating. Breakers shall be 100 percent rated.

g. Feeder circuit breakers less than or equal to 150A rating shall be molded case, group mounted, 3 Pole, 600Volt, bolt-on type with fixed thermal-magnetic trips. Interrupting RMS symmetrical ampere rating shall be 25 kAIC.

h. Circuit breakers with trip ratings greater than 250 amperes to 1000 amperes shall be UL listed as 100 percent continuous duty rated.

i. Each main, feeder, and tie circuit breaker with a frame size 400 amps and larger shall have digital electronic trip units.

6. Electronic trip devices

a. Electronic trip device shall be a digital solid state type with true RMS current sensing to provide protection from overloads, short circuits, and ground faults. Device shall include short circuit, overload, and ground fault indicators. At a minimum, the following adjustable trip parameters shall be included:

1) Long time pickup, adjustable from 50% to 100% of the rating plug value.

2) Adjustable long time delay with inverse time characteristics.

3) Switchable, adjustable short time pickup and delay with I^2t.

4) Adjustable instantaneous pickup

5) Where required provide adjustable ground fault pickup and delay with I^2t.

7. Provide arc flash energy reduction maintenance switch for all switchboard circuit breakers 1200A and higher as required by the NEC. Maintenance function shall act to minimize circuit breaker tripping time during equipment maintenance functions. Provide local status indication for each circuit breaker when energy reducing maintenance function is activated.

8. Circuit Breaker Acceptable Manufactures:

a. General Electric, Spectra RMS below 1200A; Power Break II for 1200A and larger

b. Eaton Corporation, Series C

c. Schneider/Square D

d. Approved equal.

e. Electronic trip device shall be General Electric EntelliGuard TU or MicroEntelliGuard, Eaton Corporation/Cutler Hammer Digitrip 310 or approved equal.

B. Metering Transformers

1. All instrument transformers shall be UL listed and classified as indicated in drawings.

2. Current Transformers shall be as shown on drawings with burden and accuracy to support connected meters and relays as required by ANSI/IEEE C57.13.

3. Potential transformers shall be provided where indicated on drawings with burden and accuracy to support connected meters and relays as required by ANSI/IEEE C57.13.

C. Wiring

1. Low voltage instrument and control wiring shall be copper, Type SIS, flameproof switchboard wire identified with shrink-on marker sleeves at each end. Low voltage wiring terminal blocks shall have marking strips and shall be mounted vertically in an accessible location. All terminal lugs shall be of the full loop type.

D. Marking and Identification

1. Provide nameplates identification per Section 16075.

2. A manufacturer's plaque shall be fastened to the front of the switchboard. The plaque shall indicate model number, serial number, amperes, volts, short circuit rating, etc.

3. Each switchboard shall be furnished with a sign marked "DANGER - 480 VOLTS KEEP OUT". Letters shall be not less than 1-in high, 1/4-in stroke. Signs shall be adhesive backed Mylar, OSHA approved.

E. Power Monitor – Provide Section 16290

PART 3 EXECUTION

3.1 GENERAL

A. Factory quality control: Perform manufacturers standard production testing and inspection in accordance with NEMA and ANSI standards.

B. Power monitoring equipment shall be incorporated into the power distribution equipment. Provide all mounting hardware, CTs, VTs, control power transformers, and installation details including grounding requirements to ensure that the power monitoring equipment are installed in conformance with the manufacturer and UL requirements.

C. Power monitoring equipment installation within the equipment shall not violate the manufacturer's warranty for the power monitor or the respective equipment.

3.2 INSTALLATION

A. Switchboard floor sills shall be bolted directly to the finished floor or equipment pad. Structure shall be leveled and plumb. Anchor bolts shall be as sized per Section 01612. Provide hardware and shims for installation.

B. Field installed interior wiring shall be neatly grouped by circuit and bound by plastic tie wraps. Circuit groups shall be supported so that circuit terminations are not stressed.

C. In general, all conduit entering or leaving a switchboard shall be stubbed into the bottom or top horizontal wireway directly below or above the vertical section in which the conductors are to be terminated.

D. Install the equipment in accordance with the manufacturer's instructions.

E. Remove temporary lifting angles, lugs and shipping braces. Touch-up damaged paint finishes.

F. Make wiring interconnections between shipping splits.

G. Install bus splice plates and torque connections.

H. Seal all seams, cracks, or openings in outdoor enclosures.

I. Install arc flash warning labels per Section 16080.

J. Perform final cleanup of panel interior with vacuum. Compressed air shall not be used.

3.3 FIELD QUALITY CONTROL

A. The Contractor shall make the following minimum tests and checks before the testing agency's representative is called in for testing and adjustment per the requirements of Section 16080.

1. Megger incoming line terminals and buses, phase-to-phase and phase-to-ground after disconnecting devices sensitive to megger voltage.

2. Remove current transformer shunts after completing secondary circuit. Check polarity and continuity of metering and relaying circuits.

3. Check mechanical interlocks for proper operation.

4. Test ground connections for continuity and resistance.

5. Adjust unit compartment doors.

6. Check control circuit interlocking and continuity with starters in the TEST position. Provide external source of control power for this test.

7. Adjust voltage trip devices to their correct settings.

B. In the event of an equipment fault, notify the Engineer immediately. After the cause of the fault has been identified and corrected, a joint inspection of the equipment shall be conducted by the Contractor, the Engineer and the equipment manufacturer’s factory service technician. Repair or replace the equipment as directed by the Engineer prior to placing the equipment back into service.

C. All as-built drawings shall be corrected and verified for correctness of in-field changes by the Contractor prior to submittal to the Engineer for final review.

3.4 ADJUSTMENT

A. The switchboards manufacturer shall provide the services of a factory trained service technician for start-up and training of the City’s personnel. The first trip shall be coordinated with the equipment start-up. The second trip shall include any necessary follow-up or punch list work and shall also include instructions to the City. The manufacturer's service technician shall demonstrate and test all operational features of the installed equipment to the satisfaction of the Engineer. Submit a certified copy of the field inspection to the Engineer. No equipment shall be energized without the approval of the Engineer.

B. The switchboard manufacturer's factory service technician shall make the following inspection, tests, and adjustments:

1. Calibrate and test main and feeder circuit breaker trip devices per the Coordination Study specified in Section 16080.

2. Inspect the installation for compliance with the manufacturers recommended installation practices and report all deviations to the Engineer.

3.5 CLEANING

A. Remove all rubbish and debris from inside and around the switchboard. Remove dirt, dust, or concrete spatter from the interior and exterior of the equipment using brushes, vacuum cleaner, or clean, lint-free rags. Do not use compressed air.

END OF SECTION

SECTION 16441 – PANELBOARDS

PART 1 GENERAL

1.1 DESCRIPTION

A. Work included.

1. Furnish all labor, materials, equipment and incidentals required and install all lighting and distribution panelboards as shown on the Drawings and as specified herein.

1.2 RELATED SECTIONS

A. Section 16000 – Common Work Results for Electrical.

B. Section 16080 – Electrical System Analyses and Acceptance Testing

C. Related work:

1. Panelboard schedules are shown on the Drawings.

1.3 SUBMITTALS

A. Submit shop drawings and product data in accordance with Section 01340 and Section 16000.

B. The Contractor shall furnish submittals for approval as outlined below:

1. Submit catalog cuts and descriptive literature for each type of panelboard and breaker provided.

2. Submit panelboard directory for each panelboard showing circuit allocations, breaker rating, poles, spare, short circuit, and continuous bus ratings.

3. Submit outline drawings showing panel layouts, dimensions and weights. Panel layout shall show circuit breakers allocation and available space.

1.4 REFERENCE STANDARDS

A. American National Standard Institute (ANSI)

1. ANSI Z55.1 – Gray Finishes for Industrial Apparatus and Equipment

B. Institute of Electrical and Electronics Engineers (IEEE)

1. ANSI/IEEE C37.90 – IEEE Surge Withstand Capability (SWC) Tests for Relays and Relay Systems Associated with Electric Power Apparatus

2. ANSI/IEEE C62.41 – IEEE Recommended Practice for Surge Voltages in Low-Voltage AC Power Circuits

3. ANSI/IEEE C62.45 – IEEE Guide on Surge Testing for Equipment Connected to Low-Voltage (1000 V and Less) AC Power Circuits

4. IEEE 693 – IEEE Recommended Practice for Seismic Design of Substations

C. National Electrical Manufacturers Association (NEMA):

1. PB-1 – Panelboards

D. National Fire Protection Association (NFPA):

1. NFPA 70 – National Electrical Code (NEC).

E. Underwriters Laboratories (UL).

1. UL 50 – UL Standard for Enclosures for Electrical Equipment

2. UL 67 – UL Standard for Panelboards

3. UL 1449 – UL Standard for Surge Protection Devices

F. Where reference is made to one of the above standards, the revision in effect at the time of bid opening shall apply.

PART 2 PRODUCTS

2.1 GENERAL

A. Panelboards shall be fully rated for the specified circuit breaker fault current interrupting capacity. Series connected short circuit ratings are not acceptable.

B. Provide panelboards UL listed as suitable for service entrance equipment where noted on the Drawings or as required by the NEC. Service entrance type UL Label shall be factory installed.

C. Construction

1. Panelboard construction shall be per the requirements of UL 50 and UL 67.

2. Provide panelboards with factory assembled interiors complete with bussing, circuit breakers, wire connectors, etc. All wire connectors, except screw terminals, shall be of the anti-turn solderless type, suitable for copper or aluminum wire of the sizes indicated on the Drawings.

3. Provide interiors designed so that circuit breakers can be replaced without disturbing adjacent units and without removing the main bus connectors. Circuiting changes shall be field executed without machining, drilling or tapping.

4. Branch circuits shall be arranged using double row construction except when column-type construction is indicated. Branch circuits shall be numbered by the manufacturer.

5. Provide manufacturer's nameplate listing manufacturer's name, panel type, and ratings. A second identification nameplate shall be provided on the front of each panelboard with the panelboard designation shown on the Drawings. Designation nameplates shall be as specified in Section 16075.

6. Hinged doors covering all circuit breaker handles shall be included in all panel trims. Doors shall have semi flush type cylinder lock and catch, except that doors over 48-in in height shall have a vault handle and 3-point catch with lock, arranged to fasten door at top, bottom and center. Door hinges shall be concealed. Furnish two keys for each lock. All panelboard locks shall be keyed alike.

7. Provide directory frame and card having a transparent cover on the door interior.

8. All exterior and interior steel surfaces of the panelboard shall be properly cleaned and finished with ANSI Z55.1, No. 61 light gray paint over a rust-inhibiting phosphatized coating. The finish paint shall be of a type to which field applied paint will adhere.

9. Trim for flush panels shall overlap the box by at least 3/4-in all around. Surface trim shall have the same width and height as the box. Trim shall be fastened with quarter turn clamps. Fabricate trim from code gauge sheet steel.

10. Provide at least 4 studs for mounting the panelboard interior.

D. Buses

1. Provide copper phase and neutral bus bars. Provide full-height/full-rating phase and neutral bussing without tapering or reduction. Cross connectors shall be copper.

2. Neutral bussing shall have a suitable lug for each outgoing feeder requiring a neutral connection. Provide 100% rated neutral bus except where 200% rated neutral bus is shown on the Drawings.

3. Spaces for future circuit breakers shall be bussed for the maximum number devices for the panelboard as shown on the Drawings.

4. Provide copper panelboard ground bus.

E. Boxes

1. Panelboard boxes and enclosures shall conform to the NEMA ratings as specified in Section 16000.

2. Recessed or flush mounted boxes shall be made from galvanized code gauge steel with multiple conduit knockouts.

3. Surface mounted boxes and trim shall have an internal and external finish as specified. Surface mounted boxes have blank ends, field punched for conduit entrances.

4. Boxes shall be of sufficient size to provide a minimum wire gutter space of 4-in on all sides.

5. NEMA 12 Panels

   a. Panels shall be polyester coated steel with continuously welded seams and no holes or knockouts. Covers and doors shall have gaskets and hardware shall be stainless steel.

2.2 LIGHTING AND AUXILIARY LOAD PANELBOARDS

A. Application: Provide lighting and auxiliary load panelboards (generally referred to as Lighting Panels on the Contract Documents) for serving lighting, receptacles, and ancillary project loads operating at less than 250V to ground, single or three-phase.

B. Ratings:

1. Voltage rating: 120/240V, 1 phase, 3 wire or 208Y/120V, 3 phase, 4 wire as shown on the Drawings.

2. Continuous bus current rating: as shown on the Drawings]

3. Minimum short circuit current rating: 10 kA Symmetrical

C. Circuit Breakers

1. Lighting panelboards shall be equipped with circuit breakers with frame size, number of poles, and trip settings as shown on the Drawings.

2. Circuit breakers shall be as manufactured by the lighting panelboard manufacturer.

3. Two and three-pole circuit breakers shall be constructed as a single unit with common handle. The use of single pole breakers with handle-ties, special brackets, other “ganging” means are not acceptable.

4. Lighting panel main and feeder circuit breakers shall be thermal-magnetic type. Provide bolt-on, heavy-duty breakers with toggle handles or other means to visually indicate when the unit has tripped. Provide circuit breaker interrupting rating matching or exceeding the required rating of the panelboard where installed.

5. GFCI (ground fault circuit interrupter) shall be provided for circuits where shown on the Drawings. GFCI units shall be 1 pole, 120 Volt, or 2 pole, 240 Volt as shown on the Drawings. Provide molded case, bolt-on breakers, incorporating a solid-state ground fault interrupter circuit insulated and isolated from the breaker mechanism. The unit shall be UL listed Class A Group I device (5 milliamp sensitivity, 25 millisecond trip time) and a minimum interrupting capacity of 10,000 amperes RMS. GFCI units used for heat tracing or where required by the served equipment manufacturer shall have 30 mA sensitivity.

6. Provide circuit breaker handle locks for circuits serving critical supervised loads where shown on the Drawings.

D. Acceptable Manufactures:

1. General Electric, A-Series Panelboard

2. Eaton Corporation/Cutler-Hammer, Pow-R-Line Series Panelboard

3. Square D

4. Approved equal

2.3 POWER DISTRIBUTION PANELBOARDS

A. Application: Provide power distribution panelboards (generally referred to as Distribution Panels on the Contract Documents) for serving lighting, receptacles, and ancillary project loads operating at more than 250V to ground, three-phase.

B. Ratings:

1. Voltage rating: 277Y/480 V

2. Continuous bus current rating: as shown on the Drawings

3. Minimum short circuit current rating: 10 kA Symmetrical or as shown on the Drawings

C. Circuit Breakers

1. Lighting panelboards shall be equipped with circuit breakers with frame size, number of poles, and trip settings as shown on the Drawings.

2. Circuit breakers shall be as manufactured by the distribution panelboard manufacturer.

3. Two and three-pole circuit breakers shall be constructed as a single unit with common handle. The use of single pole breakers with handle-ties, special brackets, other “ganging” means are not acceptable.

4. Distribution panel main and feeder circuit breakers shall be thermal-magnetic type, 80% rated. Provide bolt-on, heavy-duty breakers with toggle handles or other means to visually indicate when the unit has tripped.

5. GFCI (ground fault circuit interrupter) shall be provided for circuits where shown on the Drawings. GFCI units shall be 1 pole, 277 Volt, molded case, bolt-on breakers, incorporating a solid-state ground fault interrupter circuit insulated and isolated from the breaker mechanism. The unit shall be UL listed Class A Group I device (5 milliamp sensitivity, 25 millisecond trip time) and a minimum interrupting capacity of 14,000 amperes RMS rated for 30 mA ground fault protection.

6. Feeder Protective Devices

a. Feeder circuit breakers shall be 80% rated molded case 3 pole, 600 volt fixed mount circuit breakers with inverse time-current characteristics unless noted otherwise. The breakers shall be General Electric Spectra; Eaton

Corporation/Cutler Hammer Series C breaker; Square D, or approved equal.

D. Acceptable Manufactures:

1. General Electric, Spectra Series Panelboard

2. Eaton Corporation/Cutler-Hammer, Pow-R-Line Series Panelboard

3. Schneider/Square D

4. Approved equal.

PART 3 EXECUTION

3.1 INSTALLATION

A. Mount and anchor panelboards per the approved seismic anchoring calculations and recommendations where applicable. Where seismic calculations are not required, mount and anchor per manufacturer's recommendations unless noted otherwise.

B. Mount boxes for surface mounted panelboards so there is at least 1/2-in air space between the box and the wall. Mount panelboard so that height of the operating handle of the topmost mounted device is less than 6'6" (2 meters) above the finished floor or operating surface.

C. Install panelboards in accordance with manufacturer's recommendations. Connect main and branch feeder circuits on proper terminals. Minimize excess wire within the panelboard enclosure to decrease excess heat generation. Arrange cables in wiring gutter and lace together with twine or tie wraps to minimize chance of catching wire insulation on panel hardware.

D. Connect panelboard branch circuit loads so that the load is balanced and distributed as equally as possible between the phase busses based on the actual installed equipment characteristics.

E. Before energizing, verify and tighten all connectors, lugs, and mounting screws. Vacuum out all extraneous scraps of wire, plaster, dust, and other foreign material from inside the panelboard. Install dead-front shield.

F. Complete circuit directory cards giving clear, evident, and specific nature of each load served. Description shall have sufficient detail to uniquely distinguish each circuit from all others. Completed circuit directory cards shall be type written. Install circuit directories in each panelboard.

G. Install markers on the front cover of all panelboards which identify the voltage, current, and phases. Markers shall be made of self sticking B-500 vinyl cloth printed with black characters on an Alert Orange background, 2-1/4-in high by 9-in wide, Style A as manufactured by W.H. Brady Co. or approved equal.

H. Install panelboard nameplates as shown on the Drawings and as specified in Section 16000.

I. Install arc flash warning labels in conformance with NEC 110.16 and Section 16080.

J. Perform final cleanup of panel interior with vacuum. Compressed air shall not be used.

3.2 FIELD QUALITY CONTROL

A. Acceptance testing of the panelboard shall be per the requirements of Section 16080.

B. Periodically inspect panelboard during startup while under load. Verify temperature of panelboard cover surface. If surface is excessively hot, de-energize panelboard and notify the Engineer.

END OF SECTION

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SECTION 16442 – MOTOR CONTROL CENTERS

PART 1 GENERAL

1.1 DESCRIPTION

A. Work included:

1. Furnish, install and test the motor control centers as shown on the Drawings in accordance with these Specifications.

2. Motor control centers shall be sized to include all equipment, spares and spaces as shown on the Drawings.

3. The Contractor shall coordinate the size of the motor control center foot print with the size of the equipment pad and the size of the buildings in which the MCCs are to be installed.

4. The Contractor shall coordinate conduit stub up locations with the size and foot print of the motor control centers provided.

5. Provide motor control centers fully configured for network integration into the Owner's SCADA system. Starters, drives, network switches, and other networkable equipment shall be provided with network ports which support Modbus TCP protocol and are fully compatible with the Owner's SCADA system as shown on the Contract Documents.

6. Where shown on the Drawings, provide motor control centers in walk-in, structures. The motor control centers shall be shipped to the enclosure fabricator/integrator for installation prior to shipment of the fully assembled outdoor MCC to the project site. The Contractor shall be responsible for coordinating shipment of the MCCs from the MCC manufacturer to the enclosure fabricator/integrator, and ensuring that the assembled package is delivered to the project site to meet the schedule requirements of the Project.

7. Where existing motor control centers are shown as being modified or retrofitted under this Contract, provide original manufacturer approved components suitable for the application shown. Modifications or retrofits shall not alter the UL labeling of the original MCC lineup. Existing MCCs modified under this Contract include:

   a. MCC B1: GE 8000 Line. Catalog No. 0682X0490L01. Diagram No. 336B8540

B. Related sections:

1. Section 01612 – Seismic Design Criteria

2. Section 01614 – Wind Design Criteria

3. Section 11205 – Submersible Compact Mixers

4. Section 11206 – Submersible Low Speed Mixers

5. Section 11205 – Mixers, General

6. Section 11600 – Biosolids Dryer System

7. Section 13300 – Process Instrumentation and Controls – General Provisions

8. Section 16000 – Common Work Results for Electrical

9. Section 16080 – Commissioning of Electrical Systems

10. Section 16260 – Low Voltage Adjustable Speed Drives

11. Section 16260 – Low Voltage Reduced Voltage Solid State Starters

12. Section 16441 – Panelboards

13. Section 16460 – Low Voltage Dry Type Distribution Transformers

1.2 QUALITY ASSURANCE

A. The motor control centers shall be the product of a manufacturer who shall also be the manufacturer of all the circuit breakers, fused switches, motor starters, reduced voltage solid state starters, adjustable speed drives which are included in the motor control centers.

B. Motor control centers shall be designed, assembled and tested by the manufacturer of the motor control equipment included in the control center assembly; or the motor control centers shall be designed, assembled and tested by a system integrator with the integration process certified in writing by the manufacturer of the motor control equipment used in the motor control center. The written certification shall be on corporate letterhead of the motor control equipment manufacturer; confirm that the integrator follows manufacturer's specific fabrication, quality control, and testing standards; and that the manufacturer's warranty shall be in effect for all equipment installed within the motor control center by the system integrator.

C. Manufacturers, system integrators, or fabrication shops providing motor control centers shall be a UL listed and certified shop.

D. For the equipment specified herein, the manufacturer shall be ISO 9001 or 9002 certified.

1.3 SUBMITTALS

A. Submittals shall be in accordance with Sections 01340 and 16000.

B. The Contractor shall furnish submittals for approval as outlined below:

1. Equipment outline drawings showing elevation and plan views, dimensions, weight, shipping splits, conduit entrance and metering layouts. Indicate all options, special features, and ratings.

2. Itemize and describe any proposed deviations from the Specifications.

3. Unit summary tables showing detailed equipment description and nameplate data for each compartment.

4. Product data sheets and catalog numbers for all integral components such as overcurrent protective devices, motor starters, adjustable speed drives, control relays, control stations, meters, pilot lights, etc. List all options, trip adjustments and accessories furnished specifically for this Project.

5. Provide single line diagram and interconnection diagrams showing wire and terminal identification numbers.

6. Heating and cooling calculations for each panel supplied indicating conformance with cooling requirements of the supplied equipment and environmental conditions. Calculations shall include the recommended type of equipment required for both heating and cooling that will ensure maintaining the integrity of the NEMA panel rating.

7. Drawing indicating final IP addresses for each device and conform to specified City addressing requirements and standards. Standard or generic diagrams will not be acceptable.

8. Network Communications Interface.

    a. Submit network module data sheets and memory mapping for devices resident within the assembly network. Submit device parameter list with all data variables available for remote monitoring over the network interface. List shall include variable internal name, descriptive field that fully describes the contents and use of the variable, memory address and bit size, variable type (analog, discrete, text), engineering units, and function (e.g., status, alarm, internal diagnostic, etc.). Include complete configuration instructions including addressing, register allocation, data mapping, and options.

    b. Network access requirements including method for accessing equipment variables, software features, and physical hardware interface details.

9. Submit network communications factory testing procedures. Procedures shall include method for 100% testing of all variables associated with each motor starter, power monitor, adjustable speed drive, and other equipment associated with the MCC as specified. Procedure shall include factory test forms with sign-off sheets indicating proper transmittal and receipt of each variable, properly scaled, and addressed in conformance with the manufacturer's standard documentation. Include verification of each device IP address conforming to City standards.

10. Submit details of configuration software used for intelligent overloads, starters, and drives. All software specified shall be licensed to the City.

11. Submit detail and test plan for field verification of the network communications interface including verification of data receipt to the designated server as shown on the Drawings.

C. Seismic certification and equipment seismic and wind anchorage details as specified in Section 01612 and Section 01614.

D. Submit operations and maintenance manual

1. Instruction and renewal parts books.

2. Itemized list of spare parts furnished specifically for this Project, including quantities, description and part numbers.

3. Protective device time-current characteristics.

1.4 REFERENCE STANDARDS

A. Motor control centers shall be designed, built and tested in accordance with the latest editions and revisions of NEMA Standard ICS-2 and Underwriters' Laboratories Standard No. UL-845. Equipment shall conform to ANSI C19.3 test standards and the requirements of the National Electric Code.

B. Where reference is made to one of the above standards, the revision in effect at the time of bid opening shall apply.

C. National Electrical Manufacturers Association (NEMA):

1. NEMA ICS 18 – Motor Control Centers

D. Underwriters Laboratories (UL).

1. UL 489 – Molded-Case Circuit Breakers, Molded-Case Switches and Circuit-Breaker Enclosures

2. UL 508 – Industrial Control Equipment

3. UL 845 – Motor Control Centers

4. UL 1499 – Transient Voltage Surge Suppressors

5. UL 1066 – Insulated Case, Power Circuit Breakers

1.5 MANUFACTURER’S FIELD SERVICES

A. Installation.

1. Manufacturer’s representative shall be present at the site for a minimum of 16 hours for assistance, startup, testing and certification. Travel time not included.

2. Submit a manufacturer’s certificate of proper installation upon successful completion of the field testing and startup effort per the requirements of Part 3.

B. Testing.

1. The manufacturer’s service technician shall provide calibration, inspection, and adjustments per the requirements of Part 3.

1.6 SPARE PARTS

A. Spare parts shall be boxed or packaged for long term storage. Identify each item with manufacturers name, description, and part number on the exterior of the package. Provide the following spare parts in the quantities specified for motor control centers:

1. One dozen each size of cover bolts, cage nuts and door fasteners.

2. Six cans of aerosol touch-up paint.

3. 50 percent replacement fuses, all types and sizes.

4. Two of each color replacement lens caps for LED pilot lights.

5. Two size 1 starter coils.

6. Two motor starter control modules of each type provided.

7. Two of each type of printed circuit board for equipment provided under this Contract.

8. One spare ASD unit of each type provided for all ASD sizes less than 5 HP.

9. Two of each type communication module.

PART 2 PRODUCTS

2.1 MOTOR CONTROL CENTERS

A. Ratings.

1. Service type and voltage ratings shall be as shown on the Drawings.

2. The overall short circuit withstand and interrupt rating of the equipment and devices shall be as shown on the Drawings. Main and feeder circuit protective devices shall be fully rated for the specified short circuit duty. Systems employing series connected ratings for main and feeder devices shall not be used. Motor starter units shall be tested and UL labeled for the specified short circuit duty in combination with the motor branch circuit protective device.

3. The continuous current rating of the main horizontal bus shall be as shown on the Drawings. Vertical busses shall be sized for the structure and electrical loads installed in the section, and shall have a minimum rating of 300 amperes. Bus bracing shall equal or exceed the specified equipment short circuit rating.

4. Motor control centers, including devices, shall be designed for continuous operation at rated current in a 40°C ambient temperature.

B. Enclosure

1. Type shall be NEMA Type 1 Gasketed except where NEMA 3R structures are shown.

2. Where shown on the Drawings, provide MCC housed in a prewired, weatherproof, NEMA 3R, non-walk-in, modular steel enclosure.

   a. Access doors shall be gasketed with external padlockable door latch.

   b. Shielded ventilation louvers shall provide air circulation within the structure while excluding insects, vermin, moisture, and dust. Provide removable filter elements on all louvered exterior openings.

   c. Provide a structural steel base with lifting lugs and jacking plates to support the switchgear and floor plates. Provide removable steel cover plates over conduit entrance areas.

   d. A corrosion resistant, bituminous or equal structure undercoating shall be applied to the base and to the underside of the floor.

   e. Provide 120/240 Volt auxiliary power transformer and 12 Pole circuit breaker distribution panelboard conforming to Section 16442 and incorporate:

      1) One interior LED light per vertical section with common light switch at each end wall.

      2) Condensation space heaters in each breaker and auxiliary compartment.

      3) One GFI protected convenience outlet.

   f. Provide integral enclosure air conditioner to maintain MCC internal temperature within the manufacturer's rating for all MCC devices and components. AC units shall be sized based on the cooling calculations as specified herein.

C. Construction.

1. Motor control centers shall consist of a series of metal enclosed, free-standing, dead front vertical sections bolted together to form double wall construction between sections. Individual vertical sections shall be nominally 90-in high, 20-in wide and 20-in deep unless otherwise shown on the Drawings. Bottom channel sills shall be mounted front and rear of the vertical sections extending the full width of each shipping split. Top of each section shall have removable plates with lifting angle. Make provisions for field installation of additional sections to each end and provide full depth cover plates (rodent barriers) at each end of the motor control center channel sills.

2. Provide continuous top and bottom horizontal wireways extending the full width of the line-up, isolated from the horizontal bus. Provide a 9-in high horizontal wireway at the top and at the bottom in each section. Provide a 4-in wide, full height, vertical wireway in each section, equipped with a hinged door and cable supports. Vertical wireway shall be isolated from the bus and device compartments. Wireways openings shall have rolled edges or protective grommets.

3. Provide individual, flange formed, pan type door with concealed hinges and quarter turn latches for each device compartment and future space. Doors shall be removable. Door removal shall not be required to withdraw starter units or feeder tap devices.

4. Motor control centers shall be designed for against-the-wall mounting or back-to-back mounting if shown on the Drawings. All wiring, bus joints and other mechanical parts requiring tightening or other maintenance shall be accessible from the front or top.

5. Enclosures mounted on a raised concrete housekeeping or equipment pad shall include operator extension handles for the upper operator controls to comply with the NEC “Two Meter” rule.

D. Unit Compartments

1. Provide individual compartments for each removable combination starter and feeder tap device unit. Each vertical section shall accommodate a maximum of six compartments. Steel barriers shall isolate the top, bottom and sides of each compartment from adjacent units and wireways. Removable units shall connect to the vertical bus in each section with tin plated, self aligning, pressure type copper plug connectors. Size 5 and larger starter units may be wired directly to the bus. Removable units shall be aligned in the structure on guide rails or shelves and secured with a cam latch mechanism or racking screw.

2. Provide individual, isolated compartments for fixed mounted devices such as circuit breakers, cable lugs, metering, relaying and control devices. Main and bus tie circuit breakers shall be wired directly to the main horizontal bus. All bus connections shall be fully rated.

3. Provide the following features:

   a. Provision to padlock removable units in a partially withdrawn TEST position, with the bus stabs disengaged.

   b. Provision to padlock unit disconnect handles in the OFF position with up to three padlocks.

   c. Mechanical interlock with bypass to prevent opening unit door with disconnect in the ON position, or moving disconnect to the ON position while the unit door is open.

   d. Mechanical split-type terminal blocks for disconnecting external control wiring.

   e. Disconnect operating handles and control devices mounted on the removable doors or device panels.

   f. Compartments containing motor starters shall have wiring diagrams and heater tables fastened to the compartment door. Compartments containing panelboards shall have circuit directories fastened to the compartment door.

E. Bus Systems

1. Main horizontal bus: Tin plated copper, bolted joints, accessible from the front of the structure, fully rated throughout the lineup. Rating of the horizontal bus shall be per the rating of the MCC.

2. Vertical section bus: Tin plated copper, full height, totally insulated and isolated by glass polyester barriers with shutters to cover stab openings when units are withdrawn. Provide fishtape barriers to isolate bottom wireways from lower ends of vertical bus. Vertical bus rating shall be 300 A minimum, provide higher rating if required for the final MCC load arrangement as determined by the supplier.

3. Vertical buses used for a tie circuit breaker or tie feeder lugs shall be rated for a continuous capacity equivalent to the main horizontal bus rating.

4. Horizontal ground bus: Provide a tin-plated copper ground bus in each section equipped with lugs for termination of feeder and branch circuit ground conductors. Connect to ground bus in adjacent sections with splice plates where shipping splits are present. Minimum ground bus rating shall be 300A.

F. Wiring

1. Wiring: Stranded copper, minimum size No. 14 AWG, with 600 V, 90° C, flame retardant, Type MTW thermoplastic insulation, NEMA Class II, Type B. Line side power wiring shall be sized for the full rating or frame size of the connected device.

2. Identification: Numbered sleeve type wire markers at each termination point, color coding per NEMA Standards and the NEC. Foreign voltage control wiring shall be yellow.

G. Signage

1. Each motor control center shall be furnished with a sign marked "DANGER - 480 VOLTS - KEEP OUT". Letters shall not be less than 1-in high, 1/4-in stroke. Signs shall be laminated plastic, engraved white letters with a red background.

2. Compartments with voltages from sources outside of the compartment shall have a sign mounted inside the compartment door marked "CAUTION - THIS UNIT CONTAINS A VOLTAGE FROM AN EXTERNAL SOURCE". Letters shall be white on a high visibility red background.

H. Surface Preparation and Shop Coatings

1. All non-current carrying metal parts of the control center assembly shall be cleaned of all weld spatter and other foreign material and given a heat cured, phosphatized chemical pre-treatment to inhibit rust.

2. Indoor equipment shall be finish painted with one coat of manufacturers standard electrocoated, heat cured enamel.

3. Outdoor equipment shall be finish painted with two coats of polyurethane or epoxy enamel, 2 to 3 mil thickness. Exterior color shall be ANSI 61 light grey.

4. Unpainted non-current carrying parts shall receive a protective zinc plating to prevent corrosion.

I. Manufacturers:

1. Eaton/Cutler-Hammer "Freedom 2100".

2. ABB/General Electrical “Evolution Series E9000”

3. Schneider Electric/Square D “Model 6”

4. Rockwell Automation “Centerline 2100”

5. Approved equal

2.2 COMPONENTS

A. General

1. The Drawings indicate the approximate horsepower and intended control scheme of the motor driven equipment. Provide the NEMA size starter, circuit breaker trip ratings, and control power transformers ratings matched to the motors and control equipment supplied, in compliance with the National Electrical Code. All variations necessary to accommodate the motors and controls as actually furnished shall be made without extra cost to the Owner.

2. 100% rated circuit breakers are specified unless noted otherwise. If 80% rated breakers are proposed, provide circuit breakers with increased nameplate ratings to meet the equivalent 100% rating as defined in the NEC.

B. Main Circuit Breaker

1. Main circuit breaker greater than 1200A frame, shall be, insulated case type circuit breaker, individually mounted, 3 Pole, 600 Volt, 100 percent rated with a removable electronic trip plug in type device.

2. Main circuit breaker less than or equal to 1200A frame shall be, molded-case circuit breaker, individually mounted, 3 Pole, 600 Volt, 100 percent rated with a removable electronic trip plug in type device.

3. Main circuit breaker shall meet UL489 listing requirements.

C. Electronic Trip Device

1. The device shall be a digital solid state type with true RMS current sensing to provide protection from overloads, short circuits, and ground fault protection. Device shall include short circuit, overload, and ground fault indicators. At a minimum the following adjustable trip parameters shall be included:

a. Long time pickup, adjustable from 50% to 100% of the rating plug value.

b. Long time delay with inverse time characteristics.

c. Short time pickup and delay with I^2t.

d. Adjustable instantaneous pickup.

e. Ground fault pickup adjustable from 40% to 100% of the rating plug value.

f. Ground fault delay with inverse time characteristics.

2. Electronic trip device shall be Eaton Corporation Digitrip 310, General Electrical MicroEntelliGuard, Schneider/Square D, or Equal.

3. Acceptable Manufactures:

a. Eaton Corporation, Series C or Magnum DS (Magnum DS used for insulated case power circuit breaker)

b. ABB/General Electric Spectra RMS or Power Break II (Power Break II used for insulated case power circuit breaker)

c. Schneider Electric/Square D PowerPact

d. Approved equal.

D. Feeder Circuit Breakers

1. Feeder circuit breakers with a trip rating greater than 150A shall be molded case, group mounted, 3 Pole, 600 Volt, 80 percent equipment rated, plug-in type with electronic trip device.

a. Electronic trip device shall be a digital solid state type with true RMS current sensing to provide protection from overloads, short circuits and ground faults. Device shall include short circuit, overload and ground fault indicators. At a minimum the following adjustable trip parameters shall be included:

1) Long time pickup, adjustable from 50% to 100% of the rating plug value.

2) Long time delay with inverse time characteristics.

3) Short time pickup and delay with I^2t.

4) Adjustable instantaneous pickup.

b. Electronic trip device shall be Eaton Corporation Digitrip 310, ABB/General Electrical MicroEntelliGuard, Schneider/Square D Micrologix, Rockwell Automation 140G Electronic Trip, or equal.

2. Feeder circuit breakers less than or equal to 150A rating shall be molded case, group mounted, 3 Pole, 600Volt, plug-in type with fixed thermal magnetic type breaker.

3. Feeder circuit breaker shall meet UL489 listing requirements.

4. Trip unit and frame rating shall be as shown on the Drawings.

5. Acceptable Manufactures:

   a. Eaton Cutler Hammer, Series C

   b. ABB/General Electric, Spectra RMS

   c. Schneider/Square D, PowerPact

   d. Rockwell Automation, 140G

   e. Approved equal.

E. Combination Starter Units

1. Combination starters shall be plug-in type including a motor circuit protector (MCP) in series with a motor controller and an overload protective device. The MCP shall have an adjustable magnetic trip range of rated continuous current and a trip test feature. MCPs shall be labeled in accordance with UL 489.

2. Motor starters: 3 pole, 600 V, electrically operated, of the types shown on the Drawings. Provide NEMA sizes as required for the equipment horsepower shown on the Drawings. Minimum size shall be NEMA Size 1. Fractional size starters are not acceptable. Starters shall have 120 V encapsulated operating coils; individual control power transformers with primary and secondary fuses and silver cadmium oxide renewable line contacts.

3. Two-speed and reversing starters shall include two motor rated contactors mechanically and electrically interlocked so that only one device may be energized at any time. Two-speed starters shall be suitable for two-winding motor control.

4. Contactors: Electrically held, 120 VAC coil operator, suitable for tungsten, ballast, or resistive non-motor loads, with over current protection, control transformer and contact ratings and poles as shown on the Drawings.

5. Electronic Overload Relay: Thermal overload protection shall be provided using microprocessor electronic overload relays. Electronic overload relays shall be equipped with the following features at a minimum:

   a. Integral Ethernet, Modbus TCP communication or as specified herein.

   b. LEDs for status indication

   c. Test/Reset button

   d. Adjustable trip class (5 to 30)

   e. General purpose I/O (minimum 2 input 1 output)

   f. Protective functions at a minimum with programmable trip level, warning level, time delay and inhibit window:

      1) Thermal overload

2) Underload

3) Jam

4) Stall

5) Phase loss

6) Ground Fault

g. Voltage monitoring functions and summary including phase magnitude, over voltage condition, under voltage condition, and percent imbalance

h. Current monitoring functions and summary including phase average magnitude, percent of full load, and percent imbalance

i. Power monitoring functions and summary including real, reactive, apparent, power factor and maximum monitored power demand

j. Energy – kWh

k. Diagnostic information at a minimum:

1) Run time and start history

2) Device status

3) Warning status

4) Time to reset

5) Trip status

6) Time to overload trip

7) History of last 5 warnings and trips

l. Acceptable Manufactures:

1) Eaton Corporation, C441 series

2) General Electric, MM300 series

3) Schneider Electric/Square D, TeSys T series

4) Rockwell Automation, E3 Plus series

5) Approved equal

6. Auxiliary contacts: Form C, NEMA 600A rating, as required by the control schemes on the Drawings. Provide 1-normally open and 1-normally closed spare contacts on each starter. Additional auxiliary contacts shall be furnished as shown on the Drawings or as required by the control schematic and Specifications.

7. Control power transformers: Two winding type, 120 VAC secondary, with primary and secondary fuses in accordance with the NEC. Provide a minimum 50% extra capacity.

F. Digital Multimeter (DMM)

1. Provide where shown on the Drawings as specified in Section 16290

G. Surge Protective Device (SPD)

1. The SPD shall be mounted integrally with the motor control center and shall be manufactured by the same manufacture as the motor control center.

2. The suppression voltage rating (SVR) shall be tested in accordance with UL-1449

3. The SPD device repetitive surge current capacity shall be tested per the requirements of ANSI/IEEE C62.41 and ANSI/IEEE C62.45.

4. The SPD shall have maximum surge current rating of 100,000 amperes per mode at the nameplate voltage rating of the switchboard. The rating shall be based on testing of a complete SPD unit including fuses and all components that make up the SPD system. Devices that derive a maximum surge current rating by adding test results of individual components are not acceptable.

5. Provide status indicator light, form C status relay for remote monitoring, and audible alarm with enable/disable switch.

6. Acceptable Manufacturer:

a. Eaton Cutler-Hammer/Clipper Power System, Visor Series

b. General Electric, Tranquell Series

c. Schneider/Square D, IMA TVSS Series

d. Approved equal

H. Reduced Voltage Solid-State Starter (RVSS)

1. General: Provide reduced-voltage solid state motor starter housed in the Motor Control Center Structure complete with enclosure thermostatically controlled space heater and ventilation fan. RVSS components shall be tested in accordance with UL 508. The solid-state reduced-voltage starter shall be an integrated unit with power SCRs, logic board, paralleling bypass contactor, and electronic overload relay enclosed in a single molded housing.

2. The SCR-based power section shall consist of six (6) back-to-back SCRs and shall be rated for a minimum peak inverse voltage rating of 1500 volts PIV. Units using triacs or SCR/diode combinations shall not be acceptable. Resistor/capacitor snubber networks shall be used to prevent false firing of SCRs due to dV/dT effects. The logic board shall be mounted for ease of testing, service and replacement. It shall have quick disconnect plug-in connectors for

current transformer inputs, line and load voltage inputs and SCR gate firing output circuits.

3. Starter shall be rated for operation between -10 to 50 degrees C ambient and suitable at altitudes up to 3300 feet without deration. Provide conformally coated logic boards for addressing site specific environmental concerns.

4. Provide paralleling run bypass contactor that energizes when the motor reaches 90% of full speed and close/open under rated full load motor current. The paralleling run bypass contactor shall utilize an intelligent coil controller to limit contact bounce and optimize coil voltage during varying system conditions.

5. Digital interface module mounted on the face of the unit shall be used to program the soft starter. Display shall include six line LED readout. Monitoring parameters shall include line currents, pole currents, pole voltages, number of starts, and DC control voltage. Soft starter shall display motor status and the previous 5 fault conditions.

6. Starter shall be provided with electronic overload protection as standard and shall be based on inverse time-current algorithm. Overload protection shall be capable of being disabled during ramp start for long acceleration loads via digital interface module. Overload protection shall be adjusted via the device keypad and shall have a motor full load ampere adjustment from 30 to 100% of the maximum continuous ampere rating of the starter. Starter shall have selectable overload class setting of 5, 10, 20 or 30 via a DIP switch setting or the device keypad. Units using bimetal overload relays are not acceptable.

7. Starter shall be capable of either an electronic or mechanical reset after a fault.

8. Overtemperature protection (on heat sink) shall be standard.

9. Starters shall provide protection against:

    a. Improper line-side phase rotation as standard executing and orderly shutdown if a line-side phase rotation other than A-B-C exists.

    b. Phase loss or unbalance condition, shutting down if a 50% current differential between any two phases is encountered.

    c. Motor stall condition.

    d. Motor jam condition.

    e. Protection features shall be able to be enabled or disabled via the RVSS digital interface module.

10. Reduced voltage starter shall be provided with UL listed, heavy duty industrial type power factor correction capacitors mounted as part of the motor control center lineup either in dedicated MCC buckets or in a separate enclosure mounted above the associated MCC section as required by the manufacturer.

a. Power factor correction capacitors shall be as recommended, selected, and furnished by the motor control center manufacturer to raise the motor power factor to approximately 95 percent.

b. Capacitors shall be dry film or liquid insulated and shall be hermetically sealed in steel enclosures.

c. Each capacitor unit shall be furnished with three high interrupting capacity current limiting fuses. Fuses shall be equipped with "blown-fuse" indicators.

d. Provide dedicated switching contactors for the capacitor banks integrated with the RVSS starting logic to switch the capacitors into the motor circuit upon completion of the RVSS startup ramping with motor receiving full voltage and at full speed.

11. Provide the following control function adjustments from digital interface module:

    a. Selectable Torque Ramp Start or Current Limit Start

    b. Adjustable Kick Start Time: 0–2 seconds

    c. Adjustable Kick Start Torque: 0–85%

    d. Adjustable Ramp Start Time: 0.5–180 seconds

    e. Adjustable Initial Starting Ramp Torque: 0–85%

    f. Adjustable Smooth Stop Ramp Time: 0–60 seconds

12. Provide linear pump ramp logic option to allow linear ramping of centrifugal pump load based on ramping parameters entered from the RVSS keypad.

13. Maximum continuous operation shall be at 115% of continuous ampere rating.

14. Starter shall be provided with the following Form C digital output contacts:

    a. Run

    b. Fault

    c. High Temp

    d. In Bypass

    e. Ready

15. Unit shall have Modbus TCP communication option.

16. Acceptable manufactures:

    a. General Electric ASTAT IBP

    b. Eaton/Cutler Hammer S811

c. Schneider Electric/Square D, Altivar

d. Rockwell Automation, SMC

e. Approved equal.

I. Adjustable Speed Drive (ASD)

1. Rating:

a. Service Conditions

1) Input power: 460 VAC, ±10 percent, 3 phase, 60 Hz.

2) Input frequency: 57 to 63 Hz.

3) Ambient temperature: 0 degrees C to 50 degrees C.

4) Elevation: Up to 3300 feet above mean sea level.

5) Relative humidity: Up to 95 percent non-condensing.

b. Minimum drive efficiency: 97 percent or better at motor base speed and rated torque.

c. Displacement power factor: 95 percent or higher throughout the entire speed range, measured at drive input terminals.

d. Drive output: 100 percent rated current continuous at 50 degrees C, suitable for operation of the driven equipment over the required speed range without overloading. Drives shall be capable of a continuous overload up to 110 percent rated current for variable torque loads and 150 percent rated current for constant torque loads. Starting torque shall be matched to the load.

e. Output frequency drift: No more than plus or minus 0.5 percent from setpoint.

2. Construction:

a. General

1) The ASDs shall utilize a digital pulse width modulated (PWM) design to convert the fixed AC input to a variable voltage, variable frequency AC output. Construction shall be modular, using plug-in type component mounting or keyed ribbon cable connections wherever possible to minimize downtime during repair.

2) The ASD shall operate satisfactorily when connected to a bus supplying other solid state power conversion equipment which may be causing up to 10 percent total harmonic voltage distortion and commutation notches up to 36,500 volt microseconds, or when other ASD's are operating from the same bus. The drive shall include

transient voltage suppression to allow reliable operation on a typical commercial power distribution system.

3) The ASD shall consist of a full-wave diode bridge converter to convert incoming fixed voltage/frequency to a fixed DC voltage. Provide a DC link choke smoothing reactor to limit fault throughput.

4) The ASD shall have an output voltage regulator to maintain correct output Volt/Hertz despite incoming voltage variations. The ASD shall have a continuous output current rating equal to or greater than the motor full load nameplate current.

5) The ASD shall be suitable for motor control center installation.

6) The ASD shall have a local circuit breaker disconnect. Provide current limiting fuses if required by the ASD manufacturer to maintain short circuit rating.

b. Operator interface

1) Provide a mounted digital keypad/display, capable of controlling the drive and setting drive parameters. The digital display shall normally display:

a) Speed demand in percent

b) Output current in amperes

c) Frequency in Hertz

d) Control mode manual or automatic

2) The digital keypad shall allow operators to enter exact numerical settings in English engineering units. A user menu shall be provided as a guide to parameter settings. Coded messages on keypad will not be acceptable. Parameters are to be factory set in EEPROM and resettable in the field. Parameters shall be password protected. The EEPROM stored variables shall be transferable to new and spare boards.

3) At a minimum the following controls and indicators shall be provided, either separately or as part of the keypad/display to match as shown on ASD control schematic:

a) LED indicators:

- Power on
- Run
- Fault
- Motor high temperature
- Elapse time meter

b) Controls:

- Local-Off-Remote
- Start
- Stop
- Speed control
- Reset

c. ASD circuit shall have auxiliary status and alarm contacts as shown on the Drawings. ASD shall, at a minimum, have the following auxiliary contacts:

1) Run

2) Fault

3) High Temp

d. Provide Modbus TCP communication module as shown on the control schematic

3. Protective and Operational Features:

a. Make provisions for field adjustment of the following parameters through the keypad/display:

1) Current limit and boost

2) Voltage (Volts/Hertz)

3) Frequency (Minimum and Maximum)

4) Independently adjustable acceleration and deceleration rates

5) Auto restart delay

6) Up to five critical bands where drive operation is inhibited

b. Make provisions to accept a remote dry contact closure to start and stop the drive(s) with the drive control system in the AUTO mode.

c. Make provisions to accept a 4 to 20 mA DC input signal for remote speed control. Input shall be isolated at the drive and active with the drive control system in the AUTO/REMOTE mode. Zero and span adjustability shall be provided.

d. Provide the following internal protective features.

1) Transient surge protection.

2) Overcurrent protection.

3) Current limit, inverse time type.

4) DC bus fuse protection and discharge circuit.

5) DC bus overvoltage trip.

e. Provide the following output protective features:

1) The drive shall protect motor electronic motor overload protection of the motor. Provide with manual reset.

2) Provide dv/dt filter if distance is greater than 100FT from the ASD to the motor.

f. Harmonic and Radio Noise Mitigation

1) Harmonic mitigation equipment shall be provided to meet IEEE 519 requirements.

2) Provide input line reactors if required to meet IEEE 519 requirements based on field harmonic testing as required in Section 16080.

3) Provide EMI/RFI filters to limit radio frequency noise in excess of the limits specified by FCC Docket 20780 (Part 15, Subpart J) or if the drives create noise in a frequency range which will interfere with other sensitive equipment at the installation (such as lighting systems, telecommunications systems, instrumentation, and monitoring equipment).

g. Provide a digital, non-resettable, motor run time elapsed time meter.

4. Diagnostic and Fault Capability:

a. The following conditions shall cause an orderly drive shutdown and lockout.

1) Incorrect phase sequence.

2) Blown input fuse or single phasing of supply.

3) Control power supply failure.

4) Instantaneous overcurrent.

5) Sustained overload.

6) Transistor overcurrent.

7) Motor overload.

b. Provide complete built-in diagnostic and test capability to enable maintenance personnel to rapidly and accurately identify the cause of equipment failure.

5. Acceptable Manufacturers:

a. Eaton Corporation, SVX9000

b. ABB/General Electric, AF-600 FP

c. Schneider Electric/Square D, Altivar

d. Rockwell Automation, PowerFlex

e. Approved equal

J. Relays and Timers

1. Control relays and timers: 300 VAC, industrial rated, plug-in socket type, housed in a transparent polycarbonate dust cover, designed in accordance with UL Standard 508 for motor controller duty. Continuous contact rating shall be 10 amperes resistive, 1/4 HP, at 120 VAC, operating temperature minus 10 to plus 55 degrees C. Relays and timers shall be TE/Potter & Brumfield KRP Series, or approved equal with neon coil indicator light and calibrated timing knob or DIP settable controls.

K. Miscellaneous Units

1. Elapsed time hour meters: Five digit, non-reset type, with 120 V synchronous motor.

2.3 COMMUNICATIONS

A. Provide Ethernet, Modbus TCP interface integrated in each motor control center lineup as shown on the Drawings and in accordance with UL procedures and practices. Ethernet, Modbus TCP implementation requirements shall be as specified in Section 13400.

B. Each motor controller device shall communicate via Ethernet, Modbus TCP, and monitor all available controller parameters and shutdown conditions.

C. The Ethernet, Modbus TCP data communications shall be fully integrated into the unit. The Ethernet, Modbus TCP system shall be installed, configured, and tested prior to on-site installation. All Ethernet, Modbus TCP network transmission media shall be provided for a complete system, including network cable, terminations, switches, and all required network hardware.

D. Should Modbus TCP not be available as an integral protocol for the monitored equipment, provide protocol converters and gateway to implement connection to the plantwide Modbus TCP network.

E. Ethernet, Modbus TCP network cable shall be Category 5 or better and conforming to the requirements of UL 845. Ethernet, Modbus TCP cable shall have an insulating rating equal to at least the maximum circuit voltage applied to any conductor within the enclosure or raceway. Special separation, barriers, or internal conduit for the Ethernet, Modbus TCP conductors are not acceptable.

F. The Ethernet, Modbus TCP address shall be assigned to each unit during factory configuration. I/P addressing shall conform to City standards as specified in Section 13400.

2.4 HVAC SYSTEM

A. Where required for component cooling and satisfactory operation, provide MCC walk-in enclosures with air conditioning system. AC units shall be rugged, corrosion-resistant, industrial-type units with proven reliability in wastewater treatment applications. Each air conditioning unit shall operate on 480V 3-phase power supply from the associated MCC equipment with internal control step-down transformer to provide 24VAC for thermostat circuits.

B. The air conditioner housing shall be constructed of stainless steel. The evaporator and condenser of the air conditioner shall be coated with a phenolic coating for added corrosion protection. Industrial corrosion-resistant coatings shall be applied to external coils and housings for added protection. Condensate pans and piping shall be stainless or non-metallic and arranged to prevent condensate leaking into the structure.

C. The air conditioning units shall be equipped with an internally mounted economizer unit with an automatic damper to allow the enclosure to be cooled with external ambient air when the outside air temperature is lower than the interior temperature.

2.5 CONTROL SECTION

A. Control Panel Section: Provide an unbussed motor control center section integrated into the motor control center lineup(s) for the control panel specified in Section 13420 and as shown on the Drawings. Coordinate final section dimensions and other requirements with the PCSI as defined under Section 13400. Provide back pan, mounting hardware, ventilation, 120VAC power sources, motor controller monitoring and control interstructure wiring, and other auxiliary terminal blocks and components conforming to the requirements of Section 13400 and Section 13420.

2.6 FACTORY QUALITY CONTROL

A. The motor control center shall be tested per the manufactures standard factory tests.

B. Confirm proper operation of the network communications following the favorably reviewed testing procedures for testing the network interface communications including addressing of all monitored variables to preassigned registers.

C. The City reserves the right to attend the factory testing at the MCC manufacturer's facility. Provide a minimum of 4 weeks advance notice to the City of the scheduled test.

PART 3 EXECUTION

3.1 INSTALLATION

A. Motor control center floor sills shall be bolted directly to the finished floor or equipment pad per submittal approved anchorage calculations. Structure shall be leveled and plumb. Anchor bolts shall be as sized per Section 01612. Provide hardware and shims for installation.

B. Field installed interior wiring shall be neatly grouped by circuit and bound by plastic tie wraps. Circuit groups shall be supported so that circuit terminations are not stressed.

C. In general, all conduit entering or leaving a motor control center shall be stubbed into the bottom or top horizontal wireway directly below or above the vertical section in which the conductors are to be terminated.

D. Housekeeping pads shall be included for the motor control centers as detailed on the Drawings.

E. Install the equipment in accordance with the manufacturer's instructions.

F. Remove temporary lifting angles, lugs and shipping braces. Touch-up damaged paint finishes.

G. Make wiring interconnections between shipping splits.

H. Install bus splice plates and torque connections.

I. Seal all seams, cracks, or openings in outdoor enclosures.

J. Install final arc flash labeling per Section 16080.

3.2 FIELD QUALITY CONTROL

A. The Contractor shall make provisions for acceptance testing per the requirements of Section 16080.

B. In the event of an equipment fault, notify the Engineer immediately. After the cause of the fault has been identified and corrected, a joint inspection of the equipment shall be conducted by the Contractor, the Engineer and the equipment manufacturer's factory service technician. Repair or replace the equipment as directed by the Engineer prior to placing the equipment back into service.

C. Confirm proper operation of the network communications following the favorably reviewed testing procedures for testing the network interface communications including delivery of all monitored variables to preassigned registers and confirmed at the plant SCADA system per Section 13400.

D. All as-built drawings shall be corrected and verified for correctness of in-field changes by the Contractor prior to submittal to the Engineer for final review.

3.3 CLEANING

A. Remove all rubbish and debris from inside and around the control center. Remove dirt, dust, or concrete spatter from the interior and exterior of the equipment using brushes, vacuum cleaner, or clean, lint-free rags. Do not use compressed air.

END OF SECTION

SECTION 16460 – LOW-VOLTAGE DRY TYPE DISTRIBUTION TRANSFORMERS

PART 1 GENERAL

1.1 DESCRIPTION

A. Work included

1. Distribution transformers shall be provided where shown on the Drawings, single-phase or three-phase and with rated kVA.

1.2 RELATED WORK

A. Section 16000 – Common Work Results for Electrical

B. Section 16080 – Electrical System Analyses and Acceptance Testing

C. Section 16442 – Motor Control Centers

1.3 SUBMITTALS

A. Submittals shall be made in accordance with Section 01340 and Section 16000.

B. Submit the following for review:

1. Manufactures literature including equipment data sheets.

2. Plan, front, and side view drawing including overall dimensions, weights, and anchoring details.

3. Mounting bracket design for wall-mount applications.

4. Installation and O&M manuals.

1.4 REFERENCES

A. American National Standards Institute

1. ANSI Z55.1 – Gray Finishes For Industrial Apparatus and Equipment

B. Department of Energy

1. DOE 10 CFR 429 – Certification, compliance, and Enforcement for Consumer Product and Commercial and Industrial Equipment

2. DOE 10 CFR Part 431 – Energy Efficiency Program for Certain Commercial and Industrial Equipment

C. Institute of Electrical and Electronics Engineers (IEEE)

1. IEEE C57.12.01 – Standard General Requirements for Dry-Type Distribution and Power Transformer

2. IEEE C57.110 – Recommended Practice for Establishing Transformer Capability When Supplying Non Sinusoidal Load Currents

D. National Electrical Manufacturers Association (NEMA).

1. ST-20 – Dry Type Transformers for General Applications

E. Underwriters Laboratories (UL)

1. UL 1561 – Standard for Dry-Type General Purpose and Power Transformers

F. Where reference is made to one of the above standards, the revision in effect at the time of bid opening shall apply.

PART 2 PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

A. Provide transformers as manufactured by: General Electric

1. Eaton Corporation/Cutler-Hammer

2. Schneider/Square D

3. Approved equal

2.2 DISTRIBUTION TRANSFORMERS

A. General

1. Transformers shall be designed, manufactured, and tested in accordance with applicable ANSI, NEMA and IEEE standards and shall be UL listed.

2. Transformer shall be DOE 10 CFR 429 and DOE 10 CFR part 431 compliant, energy efficient for kVA rating 15kVA and higher.

3. Transformer shall be of the two winding, self-cooled type with kVA ratings as indicated on the drawings.

4. Insulation system shall be a 220°C (Class R) winding insulation system with 115° C rise and be capable of 15% continuous overload. Performance shall be based on 40°C ambient.

5. Coils shall be wound of electrical grade copper and be continuous wound construction. BIL (Basic Impulse Level) shall be 10kV.

6. Enclosure shall be made of heavy gauge steel and with ANSI 61 coating color and shall be UL recognized for outdoor use. Enclosure construction shall be ventilated, NEMA 2, drip proof. For outdoor use provide a weather shield.

7. The transformer shall include a wiring compartment for conduit entry. The maximum temperature on top of the transformer shall not exceed 90°C.

8. Sound level shall not exceed the NEMA ST-20 maximum average sound level for dry type transformers.

9. Primary and secondary voltage, phase, and kilovolt-ampere shall be as indicated on the Drawings. Provide four full capacity taps, two for 2-1/2 percent above and two for 2-1/2 percent below rated primary voltage.

10. Install transformers in motor control center structures as specified in Section 16442 where shown on the Drawings.

PART 3 EXECUTION

3.1 INSTALLATION

A. Except when installed within a motor control center, install assembly on concrete housekeeping pad or wall mounted support system as shown on the Drawings. Provide vibration-absorbing pads and securely anchor the unit to the base or wall to minimize sound transmission.

B. Transformer shall be properly anchored in accordance with the approved anchoring calculations conforming to the seismic requirements as specified in Section 01612.

C. Make final conduit connections using suitable flexible conduit as specified in Section 16130 for equipment subject to vibration and for reducing noise transmission through the conduit system.

D. Transformer neutral grounding shall be sized as shown on the Drawings. Make connections to the facility ground grid as shown on the Drawings and conforming to the NEC for separately derived systems.

E. Maintain a maximum 12” and a minimum of 6” separation from building structure for heat dissipation.

F. Provide permanent nameplate on the transformer indicating location of the disconnecting if remotely mounted from the unit.

3.2 FACTORY TESTS

A. Transformer shall be tested in accordance with IEEE C57.12.01:

1. Resistance measurements of all windings on the rated voltage connections and on all tap connections of each transformer

2. Ratio tests on the rated voltage connections and on all tap connections

3. Phase relation and polarity tests on the rated voltage connection

4. No-load losses and excitation current at rated voltage on the rated voltage connections

5. Impedance and load losses at rated current and rated frequency on the rated voltage connections of each transformer

6. Potential tests

7. Regulation and Efficiency at rated load and voltage

8. Insulation resistance tests for high voltage to ground, low voltage to ground, and high voltage to low voltage

9. Temperature tests

3.3 FIELD QUALITY CONTROL

A. Site Tests, Inspections: acceptance testing shall be as specified in Section 16080.

B. Adjust primary taps so that secondary voltage is within 2 percent of rated voltage.

END OF SECTION

SECTION 16500 – LIGHTING SYSTEM

PART 1 GENERAL

1.1 SCOPE OF WORK

A. Furnish all labor, materials, equipment and incidentals required and install a complete lighting system ready for operation as shown on the Drawings and as specified herein.

1.2 RELATED WORK

A. Section 16000 – Common Work Results for Electrical

B. Lighting fixture types referenced on the Drawings and associated descriptions are included under Appendix 16500-A.

1.3 SUBMITTALS

A. Submittals shall include those set forth in Section 16000 and shall be in accordance with Section 01340.

B. The submittals shall contain the following product information as a minimum:

1. Fixtures: Manufacturer, model number, materials of construction, finish type and color, total fixture wattage (ballast plus lamp), mounting hardware.

2. Ballasts: Manufacturer, model number, total harmonic distortion, crest factor, external wiring diagram, power factor.

3. Drivers: operational and control features, total harmonic distortion, power factor

4. Lamps: Manufacturer, model number, wattage, color temperature, color rendition index, mean lumen output, rated life.

5. Fixture photometric data in IESNA LM-63 standard format

C. All Light Emitting Diode (LED), fluorescent fixtures (except compact fluorescent), and ballasts shall be provided with certification from the manufacturer that they are bear the Environmental Protection Agency “Energy Star” certification and applicable California Tile 20 self-certification

D. LED fixture submittals shall include manufacturer’s standard DOE LED Lighting Facts label.

E. Submit lighting control panel scale interior and exterior elevation drawings, schematic control diagrams, and bill of materials indicating the details of the panels and application for controlling the associated lighting fixtures.

1.4 REFERENCE STANDARDS

A. American National Standards Institute (ANSI)

1. C82.11 – High Frequency Fluorescent Lamp Ballasts

2. S2020 – Protection of Electrical and Electronic Parts, Assemblies and Equipment

B. California Code of Regulations (CCR)

1. Title 20 – Public Utilities and Energy

2. Title 24 – Building Energy Efficiency Standards

C. Department of Energy DOE, Lighting Facts program

D. DesignLights Consortium

1. Product Qualifications Criteria

2. Qualified Products List

E. Environmental Protection Agency (EPA)

1. Energy Star for Luminaires Version 2.0

F. Federal Communications Commission (FCC)

1. CFR, Title 47, Part 15

G. Illuminating Engineering Society of North America (IESNA)

1. IESNA 63-02 – Standard File Format for the Electronic Transfer of Photometric Data and Related Information

2. IESNA 500 – Recommended Practice for Installing Indoor Commercial Lighting Systems

H. International Electrical and Electronic Engineers (IEEE)

1. IEEE C 62.41.2 – Practice on Characterization of Surges in Low-Voltage (1000V and less) AC Power Circuits

2. IEEE 1789 – Recommended Practices for Modulating Current in High Brightness LEDs for Mitigating Health Risks to Viewers

I. International Electrotechnical Commission (IEC)

1. 61000-4.2 – Testing and Measurement Techniques – Electrostatic Discharge Immunity Test

J. National Electrical Manufacturer's Association

1. LE 4 – Recessed Luminaires, Ceiling Compatibility

2. SSL 1 – Electronic Drivers for LED Devices, Arrays, or Systems

K. National Fire Protection Association (NFPA) 70, National Electrical Code

L. Underwriters Laboratories (UL)

1. UL 508A – Industrial Control Panels

2. UL 916 – Standards for Energy Management Equipment

3. UL 924 – Emergency Lighting and Exit Signs

4. UL 935 – Fluorescent-Lamp Ballasts

5. UL 1310 – Standard for Safety for Class 2 Power Units

6. UL 1598 – Luminaires

7. UL 8750 – Light Emitting Diode (LED) Equipment for Use in Lighting Products

1.5 QUALITY ASSURANCE

A. Manufacturer Qualifications:

1. Company with not less than ten years of experience manufacturing luminaires, dimming ballasts, dimming drivers, and lighting control systems.

2. Registered to ISO 9001, including in-house engineering for product design activities.

3. Manufacturing facility employing electrostatic discharge reduction practices in compliance with ANSI S20.20 or equivalent.

1.6 DELIVERY, STORAGE, AND PROTECTION

A. Receive, handle, and store products according to NECA/IESNA 500 and manufacturer's written instructions.

B. Keep products in original manufacturer's packaging and protect from damage until ready for installation.

1.7 SPARE PARTS AND MAINTENANCE

A. All spares shall be delivered in manufacturer’s packaging suitable for protection from damage during long term storage.

B. Lenses and Louvers: 5% percent of total quantity but not less than one of each type provided.

C. Extra Lamps: 10 percent of total quantity but not less than one of each type provided.

D. Extra Ballasts or External Drivers: 5% percent of total quantity but not less than one of each type provided.

PART 2 PRODUCTS

2.1 GENERAL

A. All lighting fixtures shall be in accordance with the National Electrical Code (NEC) and shall be constructed in accordance with the latest edition of the applicable Underwriters Laboratories "Standards for Safety, Electric Lighting Fixtures." All lighting fixtures shall be Underwriters Laboratories labeled.

B. Ballasts, drivers, and lamps shall comply with the requirements of the "National Energy Policy Act of 2005."

C. Provide products listed and classified by Underwriters Laboratories Inc as suitable for the purpose specified and indicated.

1. Provide products that are listed and labeled as complying with UL 1598, where applicable.

2. LED Luminaire Components: UL 8750 recognized or listed as applicable.

D. All devices shall comply with FCC requirements as listed in CFR, Title 47, Part 15 for commercial applications.

E. Unless otherwise indicated, provide complete luminaires including lamp(s) and all sockets, ballasts, reflectors, lenses, housings and other components required to position, energize and protect the lamp and distribute the light.

F. Provide all ancillary hardware required conduit, boxes, wiring, connectors, hardware, supports, trims, accessories, etc. as necessary for a complete operating system.

G. Provide products suitable to withstand normal handling, installation, and service without any damage, distortion, corrosion, fading, discoloring, etc. for the location and service specified and shown on the Drawings.

H. Recessed Luminaires:

1. Ceiling Compatibility: Comply with NEMA LE 4.

2. Luminaires Recessed in Insulated Ceilings: Listed and labeled as IC-rated, suitable for direct contact with insulation and combustible materials.

I. Emergency Power Supply Units: Suitable for use with indicated luminaires, complying with NFPA 101 and applicable state and local Codes, listed and labeled as complying with UL 924.

J. Ballasts, drivers, lamps, and controls shall comply with applicable portions of the California Energy Codes. Title 20 and Title 24.

K. All lighting control panels shall utilize UL listed components and shall be manufactured and assembled in accordance with UL Standard 508.

2.2 MATERIALS

A. Lighting Fixtures

1. Lighting fixture types shall be furnished as required by the Lighting Fixture descriptions per Appendix 16500-A. The catalog numbers are given as a guide to the design and quality of fixture desired. Equivalent designs proven with reviewed and approved calculations and equal quality fixtures of other manufacturers will be acceptable upon approval by the Engineer.

2. All LED fixtures and luminaires shall be listed on the DesignLights Consortium, Qualified Products List.

3. Where fixtures are to be installed recessed, verify the type of ceiling or wall construction and provide the appropriate frames, mounting devices, and hardware.

B. Lamps

1. Light Emitting Diode (LED) Lamps

a. Initial LED lumen output – 100% rated lumen output as specified on the Drawings

b. Light Output Depreciation Category – Category 1, Initial at 90%, 25% rated life

c. Failure Fraction – F10 (10%)

d. Color temperature:

Correlated Color Temperature	
Nominal CCT (K)	Allowable Tolerance (K)
2700	2725±145
3000	3045±175
3500	3465±245
4000	3985±275
4500	4503±243
5000	5028±283
5700	5665±355
6500	6530±510

e. Minimum color rendering index value – 80

f. Maximum color rendering index value shift – 10%

g. Power factor: 85% minimum

h. Indoor fixture ambient operating temperature rating/range: 25˚C / 0˚ to 40˚C

i. Outdoor fixture ambient operating temperature rating / range: 15˚C / -15˚ to 50˚C

j. LED Lamps shall be manufacturers by Cree, Samsung, Nichia Corporation, LumaLED, or equal.

C. LED Fixture Drivers

1. Provide constant current or voltage drivers compatible with the selected fixture Rated for operations for a minimum of 50,000 hours at maximum case temperature and 90 percent non-condensing relative humidity.

2. Provide thermal protection with automatic power output reduction to protect LED driver and LED light engine/fixture from damage due to over-temperature conditions. Reduction shall be applied when temperatures approach or exceed the LED driver's maximum operating temperature at calibration point.

3. Protective Features

a. Designed and tested to withstand electrostatic discharges without impairment when tested according to IEC 61000-4-2 or equivalent.

b. Designed and tested to withstand Category A surges of 4,000 V according to IEEE C62.41.2 without impairment of performance.

c. Meet NEMA 410 inrush requirements for mitigating inrush currents with solid state lighting sources.

d. Employ integral fault protection and overvoltage protection up to 277 V for constant voltage type; provide short circuit, open circuit, and overload protected for constant current type.

4. UL Type TL rated or UL Class P listed where specified. Suitable for field replacement as applicable; listed in accordance with UL 1598C or UL 8750, Class P where specified.

5. Class A sound rating: Inaudible in a 27 dBA maximum ambient.

6. No visible change in light output under a variation of plus or minus 10 percent change in line-voltage input.

7. Provide LED drivers designed to evenly track across multiple fixtures of the same family or series at all light levels. UL Class 2 output suitable for hot swap of LED lamps.

8. 3-Wire Control: Provide integral control circuitry where specified. Control operation shall be from input voltage of 120 V through 277 V at 50/60 Hz.

9. Dimming type where specified in the fixture descriptions. Provide dimming range 100 to 1 percent measured output current unless otherwise specified. Provide PWM output dimming frequency meeting IEEE 1789 requirements or constant current reduction method.

10. Paired with LEDs and rated at least 20% greater than the maximum wattage rating of the driven fixture.

11. Meet requirements for solid state devices for power factor, transient protection, power consumption, start time, and operating frequency per Energy Star for Luminaires. Total harmonic distortion less than 20% at maximum power.

D. Flexible Fixture Hangers: Flexible fixture hangers used in non-hazardous areas shall be type ARB and flexible fixture supports used in hazardous areas shall be type ECHF as manufactured by the Crouse-Hinds Co.; Appleton Electric Co.; Killark Electrical Mfg. Co. or approved equal.

E. Emergency Lighting Battery Units

1. Emergency lighting units and remote lighting heads shall be as specified in the "Lighting Fixture Schedule" shown on the Drawings.

2. Provide units conforming to UL 924.

3. Battery units shall be of the self-contained, fully automatic type with sealed lead acid batteries, volt-meters and time delay relays where used in H.I.D. lighted areas. Batteries shall be sized to provide 90 minutes (minimum) of lighting.

4. Unit enclosures shall be compatible to their environment.

5. All necessary mounting hardware shall be provided.

F. Emergency Exit Lighting and Signage:

1. Emergency exit lighting and signage shall be installed at designated locations shown on Drawings.

2. Emergency lighting fixtures in process and industrial areas shall be self-powered units with corrosion resistant enclosures rated NEMA 4X, temperature compensated, sealed 12 volt maintenance-free nickel cadmium batteries, high intensity incandescent light source, battery charger with LED indicator light, sealed push to test switch, and time delay.

3. Emergency Exit signs for non-process or non-industrial areas shall be similar, except with NEMA 1 enclosures.

4. Provide units conforming to UL 924.

5. Emergency Exit signs shall utilize LED style lights for illumination.

2.3 LIGHTING CONTROL PANELS

A. General

1. Lighting control panels shall be provided where shown on the Drawings.

B. In the remote mode, the lighting controls receive a permissive to operate from a remote photocell to open and close a lighting contactor. The contactors shall be capable of being turned on and off manually by operating a HAND-OFF-REMOTE/HAND-OFF-AUTO control switch located on the panel front door.

C. The panels shall be mounted as indicated on the Drawings. The number of contactors in the panels shall be as required to control the power to each load as indicated on the Drawings. Enclosures shall be rated NEMA 12 when mounted indoors and within NEMA 4X single door enclosures with provisions for padlocking when mounted outdoors. Panel identification nameplates and control device nameplates shall be mounted to the front of each panel.

D. Control power shall be 120 VAC from an external power source as shown on the Drawings. Provide circuit breaker overcurrent protection for the incoming control power including Power On light. All power and control wiring shall be stranded 12 AWG minimum and shall be identified with a unique identification number. Provide terminal blocks rated 600 volts, 20 amperes minimum for connection of all external wiring. Terminal points shall be clearly and uniquely identified with fixture locations, zones, and other physical features consistent with the Drawings.

E. Provide panel arc flash labels as required under Section 16080.

F. Lighting contactors

1. Contactors shall be electrically operated by a dual-acting, single-solenoid mechanism that is inherently interlocked and mechanically held in both the open and closed positions. The main contacts shall be power driven in both directions. Positive locking of contact positions shall not be dependent on gravity, hooks, latches or semi-permanent magnets.

2. Contactors shall operate in any position. Provisions shall be incorporated for manual operation during inspection and maintenance.

3. Contactors shall be Underwriters Laboratories listed under UL 508. Main contacts shall be double-break, continuous-duty rated 20 amperes to 600 volts AC, 60 Hz (30 amperes to 600 volts AC, 60 Hz, for general-purpose loads), and be marked for ballast lighting (electric discharge lamps). Lighting contactors requiring derating when used in an enclosure are not be acceptable.

4. Contactors shall be provided with clamp-type, self-rising terminal plates for solderless connection of line, load and control conductors. Terminals shall accept wire ranges from #18 AWG to #10AWG copper.

5. The number of poles, up to a maximum of 12, on a single remote control lighting contactor, shall be provided based on the number of fixtures controlled.

6. Contactors shall be UL listed for the following short-circuit withstand current ratings when coordinated with a UL listed molded case circuit breaker rated 30 amperes; 22,000 amps RMS symmetrical.

7. The operating coil and main contacts shall be replaceable from the front without major disassembly and visual indication shall be provided for each contact.

8. Provisions shall be included to permit remote pilot lamp-type visual indications without the necessity for auxiliary contacts or additional wiring.

9. Acceptable manufacturers:

a. ASCO 917.

b. Eaton Corporation

c. General Electric

d. Approved equal.

G. Indicating lights and selector switches

1. Provide heavy-duty, oil tight type push-to-test indicating lights and selector switches. Devices shall meet the requirements of UL 508, and have individual, legend plates indicating their specific function. Provide contacts with NEMA rating A600. Install provisions for locking selector switches in the OFF position.

2. Provide selector switches having standard operating levers. All indicating lights shall be full voltage LED transformer, push-to-test type, with lens color as indicated on the Drawings.

3. Acceptable manufacturers:

a. Eaton Corporation HT800 Series.

b. General Electric CR104P Series.

c. Allen Bradley Bulletin 800T.

d. Approved equal.

2.4 LIGHTING CONTROL DEVICES

A. Photocells

1. The photocells shall be suitable for power duty with individual fixtures or for pilot duty with contactors as detailed on the Drawings. Enclosure shall be NEMA 3R or 4. Contacts shall be rated for 1800 VA continuous at 120 volts. On-off light levels shall be adjustable with adjustable delay of up to two minutes. Orient eye to the north. Adjust the unit to turn on at 1.5 footcandles and off at 5.5 footcandles with 30 second delay.

2. Photocell shall operate on 120 Volt power input.

3. Photocells shall be TORK Model 2101 “Photoeye”; or approved equal.

PART 3 EXECUTION

3.1 INSTALLATION

A. Each fixture shall be a finished unit with all components, mounting and/or hanging devices necessary for the proper installation of the specific fixture in its designated location and shall be completely wired ready for connection to the branch circuit wires at the outlet.

B. Interior installations shall be in accordance with IESNA 500.

C. Coordinate the installation of luminaires with mounting surfaces as shown on the Drawings. Coordinate the work with placement of supports, anchors, etc. required for mounting. Coordinate compatibility of luminaires and associated trims with mounting surfaces at installed locations.

D. Coordinate the placement of luminaires with structural members, ductwork, piping, equipment, diffusers, fire suppression system components, and other potential conflicts provided under other sections.

E. All flush mounted fixtures shall be supported from the structure and shall not be dependent on the hung ceilings for their support.

F. Install luminaires plumb and square, aligned with building lines and with adjacent luminaires. Provide extension rings to bring outlet boxes flush with finished services

G. Fixtures noted to be installed flush in suspended ceilings shall be of mounting types suited for the type ceiling involved. It shall be the responsibility of the Contractor to verify the ceiling types prior to ordering fixtures. In addition to ceiling support wires, provide two, dedicated galvanized fixture safety wires connected opposing corner of each recessed luminaire to the building structure.

H. Flexible fixture hangers shall be used for all pendant mounted fixtures. Fixtures two feet long and larger shall be supported with a minimum of two fixture hangers. Pendant fixtures shall be supported from rigid conduit. The use of threaded rods is not acceptable. Provide separate grounding conductor connected to a ground bushing or lug in the outlet box.

I. Conduit run in areas with hung ceilings shall be installed in the space above the hung ceiling as close to the structure as possible. Conduits shall be supported from the structure.

J. Fixture locations are shown on the Drawings in approximate locations; however exact locations shall be coordinated to avoid conflicts with HVAC ducts, equipment, and other obstacles.

K. Photocells shall be mounted facing north and in a location that is unaffected by light fixture sources.

L. Motion sensors shall be mounted and configured to track motion in main egress locations or in areas as necessary for ensuring site security.

3.2 ADJUSTMENT

A. Aim and position adjustable luminaires to achieve desired illumination as indicated or as directed by the Engineer. Adjust luminaires to avoid glare and light leakage to areas outside of the facility property lines.

3.3 STARTUP

A. Operate each luminaire after installation to verify proper operation.

B. Test emergency power supply units to verify proper operation upon loss of power. Replace drivers or ballasts that exceed the manufacturer's rated noise levels or that exceed Project specified noise limits.

C. Protect installed luminaires from subsequent construction. Replace any damaged or failed lamps prior to substantial completion.

D. All lamps used during construction, except for LED, HID, and LED amps, shall be removed and replaced with new lamps two weeks from completion of the work.

3.4 CLEANING UP

A. Plastic dust cover bags that are provided with new parabolic reflector lighting fixtures shall be removed after all construction activity which may cause dust formation on reflector surfaces has been completed.

B. Clean surfaces according to IESNA 500 and manufacturer's instructions to remove dirt, fingerprints, paint, foreign spatter or materials. Restore finishes to match original factory finish. All fixtures shall be left in a clean condition, free of dirt and defects, before acceptance by the Engineer.

END OF SECTION

APPENDIX 16500-A

LIGHTING FIXTURES

Note: Fixture letter designations used in this Appendix are referenced on the Drawings. The manufacturer and part numbers listed are intended as a guide to the Contractor and are not intended to preclude selection and use of equivalent fixtures made by an alternative manufacturer.

LIGHTING FIXTURES SCHEDULE

APPENDIX 16500 – A

Fixture Type: **A**

Commercial LED

General: Recessed static troffer for grid inverted T-Bar ceilings, pattern 12 lens, high performance isolated driver sealed to IP66 protection levels, Class A sound rating, listed to ULI598 safety standards.

Description:

Manufacturer and model number:

LSI Industries:

GA24-LED-SS-NW-UE;

or approved equal.

Lamp Type:

4000K LED, 5160 Lumens

Driver Type:

LED Light engine, 0-10V, dimmable

Mounting Arrangement:

Recessed

Input:

Max Wattage (including driver):

45W

Voltage:

120 VAC

Notes:

None.

APPENDIX 16500 – A1

Fixture Type: **A1**

Commercial LED

General: Same as type A, except 3027 lumens and 2' x 2' normal fixture size.

Description:

Manufacturer and model number:

LSI Industries:

GA22-LED-SS-NW-UE;

or approved equal.

Lamp Type:

4000K LED, 3027 Lumens

Driver Type:

LED Light engine, 0-10V, dimmable

Mounting Arrangement:

Recessed

Input:

Max Wattage (including driver):

29W

Voltage:

120 VAC

Notes:

None.

APPENDIX 16500 – B

Fixture Type: B

Industrial LED

General: Dome wrap light fixture, code gauge die form steel housing, frosted acrylic lens, high performance driver, suitable for damp locations.

Description:

Manufacturer and model number:

LSI Industries:

DW-LED-SS-NW-UE

or approved equal.

Lamp Type:

4000K LED, 5220 Lumens

Driver Type:

LED Light engine, 0-10V, dimmable

Mounting Arrangement:

Pendant/Surface

Input:

Max Wattage (including driver):

44W

Voltage:

120 VAC

Notes:

Provide with hanging assembly as required.

APPENDIX 16500 – C

Fixture Type: **C**

Industrial LED

General: Exterior wall mounted LED lighting fixture, power coat finish, precision molded acrylic lens night time friendly, CSA certified to U.S. standards.

Description:

Manufacturer and model number:

Lithonia:

CSXW-LED-30C-700-40K-T3M-120-PE-DMG-DNAXD;

or approved equal.

Lamp Type:

4000K LED, 7068 Lumens

Driver Type:

LED Light engine, 0-10V, dimmable

Photoelectric Cell

Mounting Arrangement:

Wall mount

Input:

Max Wattage (including driver):

69W

Voltage:

120 VAC

Notes:

Provide with photoelectric cell.

Fixture Type: C1

Industrial LED

General: Exterior wall mounted LED lighting fixture, power coat finish, precision molded acrylic lens night time friendly, CSA certified to U.S. standards.

Description:

Manufacturer and model number:

Lithonia:

CSXW-LED-30C-700-40K-T3M-120-DMG-DNAXD;

or approved equal.

Lamp Type:

4000K LED, 7068 Lumens

Driver Type:

LED Light engine, 0-10V, dimmable

Mounting Arrangement:

Wall mount

Input:

Max Wattage (including driver):

69W

Voltage:

120 VAC

Notes:

None.

APPENDIX 16500 – D

Fixture Type: **D**

Industrial LED

General: I-beam high bay light fixture, semi diffused acrylic lens, class I Philips advanced LED driver, 0-10V dimming leads, wide distribution.

Description:

Manufacturer and model number:

Lithonia:

IBL-24L-WD-SD125-120-LP740-WGX

or approved equal.

Lamp Type:

4000K LED, 24,000 Lumens

Driver Type:

LED Light engine, 0-10V, dimmable

Mounting Arrangement:

Pendant

Input:

Max Wattage (including driver):

245W

Voltage:

120 VAC

Notes:

Provide with hanging assembly as required

APPENDIX 16500 – E

Fixture Type: **E**

Self-contained battery powered light fixture

General: Emergency lighting unit, Nickle-Cadmium battery, test switch and status indicator, U.L. listed for indoor damp locations.

Description:

Manufacturer and model number:

Lithonia:

EU2- LED-M12;

or approved equal.

Lamp Type:

(2) 1.8W LED LAMP HEADS

Driver Type:

LED Light engine

Mounting Arrangement:

Wall mount

Input:

Max Wattage (including driver):

3.6W

Voltage:

120 VAC

Notes:

Unit shall be capable of operating 1-1/2 hours on internal battery.

APPENDIX 16500 – E1

Fixture Type: **E1**

Self-contained battery powered light fixture

General: Class II., Div. I, Groups E, F, G, Emergency lighting unit, Nickle-Cadmium battery, test switch and status indicator, U.L. listed for 844, 924 and 1203. (Explosion proof and dust ignition proof electrical equipment)

Description:

Manufacturer and model number:

Cooper Crouse-Hinds:

ELPS502

or approved equal.

Lamp Type:

#789 miniature tungsten halogen, G4, 2-pin, 14 watt.

Driver Type:

Mounting Arrangement:

Wall mount

Input:

Max Wattage:

28W

Voltage:

120 VAC

Notes:

Unit shall be capable of operating 1-1/2 hours on internal battery.

Fixture Type: F

Exit Sign

General: Emergency exit sign. Battery charger with red indicator light, sealed Nickle-Cadmium battery, status indicator test switch U.L. listed for damp locations.

Description:

Manufacturer and model number:

Lithonia:

LQC-W-1-R-ELN;

or approved equal.

Lamp Type:

LED (LIGHT EMITTING DIODE)

Driver Type:

LED light engine

Mounting Arrangement:

Universal Mounting

Input:

Max Wattage (including driver):

0.6W

Voltage:

120 VAC

Notes:

Unit shall be capable of operating 1-1/2 hours on internal battery.

APPENDIX 16500 – F1

Fixture Type: **F1**

Exit Sign

General: Class II., Div. II., Groups E, F, G. Emergency exit sign. Battery charger with red indicator light, sealed Nickle-Cadmium battery, status indicator test switch U.L. listed for damp locations. U.L. listed 844, 924, 1203 (explosion proof and dust ignition proof electrical equipment).

Description:

Manufacturer and model number:

Cooper Crouse-Hinds:

Ex Lite ZE

or approved equal.

Lamp Type:

LED (LIGHT EMITTING DIODE)

Driver Type:

LED light engine

Mounting Arrangement:

Wall Mount

Input:

Max Wattage (including driver):

6W

Voltage:

120 VAC

Notes:

Unit shall be capable of operating 1-1/2 hours on internal battery.

APPENDIX 16500 – G

Fixture Type: **G**

Industrial LED

General: Single piece die-cast aluminum housing, acrylic lens, type 3 distribution, sealed against moisture and contaminants, nighttime friendly, U.L. listed for wet locations.

Description:

Manufacturer and model number:

Lithonia Lighting:

DSX0-LED-P6-40K-T3M-120-RPA-DMG-HS-DNAXD

or approved equal.

Lamp Type:

4000K, 15,975 lumens

Driver Type:

LED light engine

Mounting Arrangement:

Straight Stanchion Mount

Input:

Max Wattage (including driver):

134W

Voltage:

120 VAC

Notes:

Provide with 1-1/2" conduit stanchion mount.

Provide with house side shield.

APPENDIX 16500 – G1

Fixture Type: **G1**

Industrial LED

General: Single piece die-cast aluminum housing, acrylic lens, type 3 distribution, sealed against moisture and contaminants, nighttime friendly, U.L. listed for wet locations.

Description:

Manufacturer and model number:

Lithonia Lighting:

DSX0-LED-P2-40K-T3M-120-RPA-HS-DNAXD;

or approved equal.

Lamp Type:

4000K, 6011 lumens

Driver Type:

LED light engine

Photoelectric cell

Mounting Arrangement:

Straight Stanchion Mount

Input:

Max Wattage (including driver):

49W

Voltage:

120 VAC

Notes:

Provide with 1-1/2" conduit stanchion mount.

Provide with House side shield

Provide with photo electric cell SSL Twist-Lock (120-277v)

APPENDIX 16500 – H

Fixture Type: H

Industrial LED Area Lighting

General: Low Copper Aluminum alloy housing, listed to UL 1598 Standard for luminaries, UL8750 CSA C22.2 #250 luminaries, ROH.S compliant, 0-10V dimming interface. Type 3 distribution.

Description:

Manufacturer and model number:

KIM LIGHTING:

WP9S-3-P70-60L-4K-UV-LG-A30

or approved equal.

Lamp Type:

4200K, 11069 LUMENS

Driver Type:

LED light engine

Mounting Arrangement:

Pole Mount

Input:

Max Wattage (including driver):

131W

Voltage:

120 VAC

Notes:

Provide with 20ft., RSA series, round non-tapered aluminum pole, and photoelectric cell.

APPENDIX 16500 – H1

Fixture Type: **H1**

Industrial LED Area Lighting

General: Same as Type H.

Description:

Manufacturer and model number:

KIM LIGHTING:

WP9S-3-P70-60L-4K-UV-LG-A30

or approved equal.

Lamp Type:

4200K, 11069 LUMENS

Driver Type:

LED light engine

Mounting Arrangement:

Pole Mount

Input:

Max Wattage (including driver):

131W

Voltage:

120 VAC

Notes:

Same as Type H, except with 12 foot pole.

APPENDIX 16500 – H2

Fixture Type: H2

Industrial LED Area Lighting

General: Same as Type H.

Description:

Manufacturer and model number:

KIM LIGHTING:

WP9S-3-P70-60L-4K-UV-LG-A30

OR APPROVED EQUAL.

Lamp Type:

4200K, 11069 LUMENS

Driver Type:

LED LIGHT ENGINE

Mounting Arrangement:

POLE MOUNT

Input:

Max Wattage (including driver):

131W

Voltage:

120 VAC

Notes:

Same as Type H, except with 8 foot pole.

APPENDIX 16500 – J

Fixture Type: **J**

BOLLARD

General: Die-cast aluminum domed top cap, horizontal lolmer blades, tempered molded glass lamp enclosure. 0-10v dimming interface, U.L. standards 1598 and 8750.

Description:

Manufacturer and model number:

KIM LIGHTING:

VRB1-15L-4K-UV-LG

OR APPROVED EQUAL.

Lamp Type:

4000K LED, 703 LUMENS

Driver Type:

LED LIGHT ENGINE

Mounting Arrangement:

BOLLARD

Input:

Max Wattage (including driver):

19W

Voltage:

120 VAC

Notes:

None.

APPENDIX 16500 – K

Fixture Type: **K**

Industrial LED

General: Die-cast aluminum housing, prismatic glass refractor, multi-gasketing weather proof protection. 0-10v dimmable driver, complied with ANSI: C136.2, C136.10, C136.15.

Description:

Manufacturer and model number:

AMERICAN ELECTRIC LIGHTING:

245L-20LEDE70-MVOLT-4K-R3-GL-NR-HSS

OR EQUAL.

Lamp Type:

4000K LED, 4457 LUMENS

Driver Type:

LED LIGHT ENGINE, 0-10V, DIMMABLE

Mounting Arrangement:

POLE MOUNT

Input:

Max Wattage (including driver):

45W

Voltage:

120 VAC

Notes:

HOOD STYLE A.

APPENDIX 16500 – L

Fixture Type: **L**

INDUSTRIAL LED CANOPY LIGHT

General: CAST-ALUMIMUM CORROSION RESISTANT HOUSING CASTINGS SEALED WITH BRONZE POLYESTER POWDER PAINT. POLYCARBONATE LENS. U.L. LISTED FOR WET LOCATIONS.

Description:

Manufacturer and model number:

LITHONIA:

VRC-LED-50K-MVOLT

OR EQUAL.

Lamp Type:

5000K LED, 3389 LUMENS

Driver Type:

LED LIGHT ENGINE

Mounting Arrangement:

CEILING

Input:

Max Wattage (including driver):

41W

Voltage:

120 VAC

Notes:

NONE.

Fixture Type: M

INDUSTRIAL LED FLOODLIGHT

General: DIE-CAST ALUMINUM HOUSING COMPLETELY SEALED, LOW OPERATING TEMPERATURE, U.L. LISTED FOR WET LOCATIONS.

Description:

Manufacturer and model number:

LITHONIA:

DSXF2LED-P2-40K-WFL-120-THK-DMG-DNAXD

OR EQUAL.

Lamp Type:

4000K LED, 10680 LUMENS

Driver Type:

LED LIGHT ENGINE

Mounting Arrangement:

POLE MOUNT

Input:

Max Wattage (including driver):

78W

Voltage:

120 VAC

Notes:

PROVIDE WITH 20FT, RSA SERIES, ROUND NON-TAPERED ALUMINUM POLE.

APPENDIX 16500 – M1

Fixture Type: **M1**

INDUSTRIAL LED FLOODLIGHT

General: SAME AS TYPE M.

Description:

Manufacturer and model number:

LITHONIA:

DSXF2LED-P2-40K-WFL-120-THK-DMG-DNAXD

OR EQUAL.

Lamp Type:

4000K LED, 10680 LUMENS

Driver Type:

LED LIGHT ENGINE

Mounting Arrangement:

POLE MOUNT

Input:

Max Wattage (including driver):

78W

Voltage:

120 VAC

Notes:

SAME AS TYPE M EXCEPT WITH 12 FOOT POLE.

APPENDIX 16500 – N

Fixture Type: **N**

INDUSTRIAL LED

General: LED Factory Sealed Explosion Proof, Dust-proof Class 1, Division 1

Description: Class I, Division I, Group G, Explosion proof lighting fixture. Factory sealed. Suitable for use where ignitable vapors, dust and corrosive elements are present.

Manufacturer and model number:

APPLETON:

CMLEDA252D5BUCG

OR EQUAL.

Lamp Type:

5650 LED, 8050 LUMENS

Driver Type:

LED LIGHT ENGINE

Mounting Arrangement:

PENDANT

Input:

Max Wattage (including driver):

108W

Voltage:

120 VAC

Notes:

Provide with mounting hood, diffused glass globe, safety cable and wire guard.

APPENDIX 16500 – P

Fixture Type: **P**

Industrial LED Roadway Lighting

General: Die Cast Aluminum housing, Micro-Lens optical system, standard 3-wire photocontrol receptacle, U.L. listed for wet locations, 0-10V dimming interface. Type 3 distribution.

Description:

Manufacturer and model number:

LeoTeck Electronics:

GC1-SOF-MV-NW-3-GY-700-HSS

or approved equal.

Lamp Type:

4000K, 17,770 lumens.

Driver Type:

LED light engine.

Mounting Arrangement:

Pole Mount

Input:

Max Wattage (including driver):

180W

Voltage:

480 VAC

Notes:

Provide with 31'-6" galvanized steel pole and mast arm, Valmont DS32800A30065-GV-FR or union metal T71041-Y16-180-FRC.

SECTION 16600 – UNDERGROUND DUCTS AND RACEWAYS FOR ELECTRICAL SYSTEMS

PART 1 GENERAL

1.1 DESCRIPTION

A. Work included:

1. Furnish and install a complete underground system of raceways, handholes, fittings, and hardware as shown on the Drawings and as specified herein.

2. Where referred to in this Section, raceways are underground conduits and fittings; ductbanks are a collection of underground raceways; the underground electrical system is the collection of underground ductbanks, handholes, hardware, and other below and at grade structures as specified.

3. Install ductbanks and handholes locations and depths coordinated with other utilities, yard piping, yard structures and field conditions per the Contract Documents. Underground electrical systems shall be installed to avoid interferences with other utilities, structures, and site features.

4. All underground electrical raceway systems shall be encased in steel reinforced concrete ductbanks unless specifically indicated otherwise on the Drawings. Ductbanks shall be steel reinforced, concrete encased, and structurally tied to buildings, vaults, handholes or other structures where shown on the Drawings and where specified.

5. Related Work: Underground electrical systems for electrical power, telephone, or other utility shall be in conformance with the requirements of the serving utility as applicable and per the requirements of Section 16000.

1.2 RELATED SECTIONS

A. All trenching, drilling, backfill, compaction, and surface restoration shall be as indicated on the Drawings and as required under Division 2 of these Specifications. However, the responsibility of furnishing and installing the underground systems shall be included under this Section.

B. All concrete and reinforcement shall be as indicated on the Drawings and as required in Division 3 of these Specifications. However, the responsibility of furnishing and installing the underground systems shall be included under this Section.

C. Section 03305 – Electrical and Instrumentation Duct Encasement Concrete

D. Section 16000 – Common Work Results for Electrical

E. Section 16060 – Grounding and Bonding for Electrical Systems

F. Section 16130 – Raceways and Boxes for Electrical Systems

1.3 SUBMITTALS

A. Submittals shall be made in accordance with Section 01340 and Section 16000.

B. Concrete mix design for ductbank concrete encasement shall be submitted per the requirements of Division 3.

C. Submit the following:

1. Raceway and conduit product catalog data indicating material, fittings, accessories, and sizes to be provided.

2. Handhole and splice boxes catalog data including details of the structures and lids including material of construction, design loadings, knockout locations, internal and external dimensions, sump locations, and accessories.

3. Catalog data for underground raceway installation accessories including conduit spacers, cable racks, pull rope, pulling lubricants, sealants, identification warning tape, and other underground system components as specified herein.

1.4 REFERENCES

A. Pacific Gas and Electric Company (PG&E), Electric & Gas Service Requirements (Green Book)

B. American National Standards Institute

1. ANSI C80.1 – Electrical Rigid Steel Conduit (ERSC).

C. American Society for Testing and Materials (ASTM)

1. ASTM C857 – Standard Practice for Minimum Structural Design Loading for Underground Precast Concrete Utility Structures

2. ASTM D1784 – Standard Specification for Rigid Poly (Vinyl-Chloride) (PVC) Compounds and Chlorinated Poly (Vinyl-Chloride) (CPVC) Compounds

3. ASTM F512 – Standard Specification for Smooth-Wall Poly (Vinyl-Chloride) (PVC) Conduit and Fittings for Underground Installation

D. California Code of Regulations.

1. Title 24, Part 3 – California Electrical Code (NEC)

E. Federal Specifications (FS)

1. FS W-C-1094 – Conduit and Conduit Fittings Plastic, Rigid

F. National Electrical Manufacturer's Associate (NEMA)

1. NEMA RN1 – Polyvinyl-Chloride (PVC) Externally Coated Galvanized Rigid Steel Conduit and Intermediate Metal Conduit.

2. NEMA TC2 – Electrical Polyvinyl Chloride (PVC) Conduit

3. NEMA TC3 – Polyvinyl Chloride (PVC) Fittings for Use with Rigid PVC Conduit and Tubing

4. NEMA TC6 and 8 – Polyvinyl chloride (PVC) Plastic Utilities Duct for Underground Installations

G. The American Association of State Highway and Transportation Officials (AASHTO)

1. AASHTO T 180 – Standard Method of Test for Moisture-Density Relations of Soils Using a 4.54-kg (10-lb) Rammer and a 457-mm (18-in.) Drop

H. Public Utilities Commission State of California

1. General Order No.128, Rules for Construction of Electric Supply and Communication Systems.

I. United Stated Department of Agriculture: Rural Utilities Service (RUS)

J. Underwriters Laboratories (UL)

1. UL 6 – Electrical Rigid Metal Conduit - Steel

2. UL 514B – Fittings for Conduit and Outlet Bodies

3. UL 651A – Type EB and A Rigid PVC Conduit and HDPE Conduit

K. Where reference is made to one of the above standards, the revision in effect at the time of bid opening shall apply.

1.5 QUALITY ASSURANCE

A. Raceways, fittings, and other underground electrical system components shall be UL listed where such listings are available.

PART 2 PRODUCTS

2.1 RACEWAYS AND FITTINGS

A. Rigid Polyvinyl Chloride Conduit (PVC) and Fittings

1. PVC conduit shall be Schedule 40, UL listed for concrete encased, underground direct burial, concealed, and direct-sunlight, weather-exposed use. Provide PVC conduit manufactured from virgin PVC compounds conforming to UL 651, listed and marked for use with 90° C insulated conductors.

2. PVC conduits, couplings, elbows, nipples, and other fittings shall meet the requirements of NEMA TC 2 AND TC 3, Federal Specification W-C-1094, NEC Article 352, and ASTM D-1784 specified tests for the intended use.

3. Provide conduits having a factory formed bell on one end. Conduit that requires the use of couplings for straight runs will not be acceptable.

4. Provide factory elbows and large radius sweep bends with standard radii for all underground installations. Elbows and bends shall be by the same manufacture as the straight conduit and match PVC requirements as specified herein.

5. Acceptable Manufacturers:

   a. Carlon/Thomas and Betts (Lamson & Sessions) Plus 40 Rigid PVC Nonmetallic Conduit

   b. PW Eagle (PW Pipe)

   c. Allied Tube and Conduit (Tyco)

   d. Approved equal

B. PVC Coated RGS Conduit:

1. PVC-coated rigid steel conduit shall be hot-dipped galvanized rigid steel conduit meeting the requirements of NEMA RN 1, UL/6, and ANSI C80.1. Provide a factory installed PVC coating, 40 mils nominal thickness, and applied over and permanently bonded to the galvanized surface. Coating shall include an interior 2 mil urethane coating.

2. All male threads on conduit, elbows, nipples and other fittings shall be protected by an application of a urethane coating; they shall be threaded and galvanized with integral plastic sleeves overlapping the plastic-coated conduit.

3. Provide PVC coated conduit suitable for conductors with 75ºC insulation.

4. Acceptable Manufacturers:

   a. Robroy, Plasti-Bond Red

   b. Thomas and Betts, “OCAL”

   c. Perma-Cote Industries, Supreme Conduit System

   d. Approved equal

C. Connectors, Couplings, and Fittings

1. Connectors, couplings, fittings and ancillary materials shall be by the same manufacturer as the supplied conduit.

2. End Bells: Provide PVC bell ends to fit on conduit termination points. End bells shall be installed at all termination points for mitigation of potential damage to conductor insulation during wire pulling and installation. End bells shall be smoothly tapered without sharp or rough edges to minimize chance of insulation damage.

3. End Caps: Provide PVC end caps to plug spare conduits and protect against entry of rodents, water, or dirt into the spare conduit. Provide end caps designed to fit into the end of standard conduit trade sizes and include integral cap eyelet for tying off spare conduit pull ropes or string.

2.2 IDENTIFICATION WARNING TAPE

A. Provide underground detectable warning tape. The tape shall be constructed of solid aluminum core that is laminated with a protective clear film on both sides, sealing and protecting the graphics from underground moisture, acids and alkalis. Tape color shall be red and be 6-inch minimum width, with black lettering, for use in trenches containing electric circuits. Use tape with printed warning "CAUTION-BURIED ELECTRIC LINE BELOW" or similar for single, telephone, fiber, network or other wiring systems.

B. Warning tape shall be as manufactured by Seton Inc., Panduit Corporation or approved equal.

2.3 CONDUIT SPACERS

A. Conduits installed in concrete encased ductbanks shall include spacers to provide uniform support and protection of conduits prior to concrete encasement or soil/sand backfill. The spacers shall be made of high density polyethylene and be of the interlocking module type.

B. The spacers shall be arranged such that the centerline distance between the conduits is as shown on the Drawings

C. Spacers shall be manufactured by Carlon/Thomas and Betts (Lamson & Sessions); Underground Devices Inc.; Formex Manufacturing, or approved equal.

2.4 CONDUIT WALL PENETRATION SEALS AND SLEEVES

A. Refer to Section 16130.

2.5 DUCT SEAL

A. Refer to Section 16130.

2.6 EXPANSION/DEFLECTION COUPLINGS

A. Refer to Section 16130.

2.7 CABLE RACKS

A. Provide nonmetallic high load capacity cable racks for installation within handholes or other structures. Cable racks shall consist of wall mounted stanchion with adjustable mounting locations for rack arms. Rack arms shall lock into the stanchion piece. Provide cable arms with suitable lengths for individual mounting of power cables without bundling and as appropriate for the internal dimensions of the underground structure. Cable arms shall include manufactured slots for installation of cable ties. Cable racks shall have sufficient mechanical strength for the size cables shown installed on the Drawings. Provide stainless steel mounting and anchoring hardware for installation of the cable racks. Provide cable racks as manufactured by Underground Devices Incorporated or approved equal.

2.8 HANDHOLES

A. Provide type and size of handhole per the Handhole Schedule included in the Drawings. Minimum size handhole provided shall be 24” x 36” internal dimensions (nominal) for all handholes shown on the Drawings unless otherwise noted in the Schedule.

B. Supports, pulling in irons, and hardware shall be galvanized steel.

C. All handholes shall have solid bottoms with sump knockouts for drainage of water.

D. Provide extensions as required such that the depth of the handhole is coordinated with the depth of the ductbank and finished grade.

E. Metal covers and other exposed conductive surfaces within the handhole shall be bonded per NEC Article 250. Provide grounding strap between metal cover and metal frame or other metal surface in handhole for continuity of grounding system within the handhole. Ground rods where shown on the Drawings and other grounding materials and methods shall be as specified under Section 16060.

F. Handholes shall be precast concrete, heavy duty type, designed for a HS20-44 wheel load plus the weight of the soil above (using 120 pcf for the soil weight), impact loads, and hydrostatic loads in accordance with ASTM C857. Handhole covers shall be hinged steel with spring assist and include penta head type lock-down cover bolts.

G. Cover functional identification shall be included on every handhole cover. Identification shall be permanently engraved on the cover and shall indicate the handhole identification number as shown on the Drawings and the following as applicable:

   1. “Electrical” for 600V and below circuits

   2. “High Voltage” for medium and high voltage circuits

   3. “Communications” for all network systems including telephone and fiber optic cables

   4. “Signal” for instrumentation signals including 24VDC cables.

H. Precast units shall be as manufactured by Oldcastle Precase, Inc; Jensen Precast; or approved equal and constructed to dimensions as shown on the Drawings.

I. Conduit Identification: Provide conduit identification tags as specified in Section 16130.

PART 3 EXECUTION

3.1 GENERAL

A. Prior to trenching and installing underground conduits and/or underground ductbanks the Contractor shall verify field conditions and address all potential conflicts with other underground utilities, structures, or features.

B. Protection during construction:

1. Store all products in a clean, dry location prior to installation. Following installation, protect products from the effects of moisture, corrosion, and physical damage during construction. Keep openings in conduit and tubing capped with manufactured end caps during construction. Cover and protect PVC conduit, elbows, and PVC coated rigid steel conduit, nipples, elbows, and fittings from exposure to sunlight.

3.2 REQUIRED RACEWAY TYPE FOR LOCATION AND INSTALLATION METHOD

A. Provide rigid non-metallic conduit at all locations except at conduit risers where PVC coated GRS conduits shall be used as shown on the drawings.

B. See also Section 16130.

3.3 INSTALLATION REQUIREMENTS FOR UNDERGROUND RACEWAYS

A. General:

1. Trenching, shoring, backfill, compaction, and finished exterior surfaces shall conform with the requirements of Division 2.

2. Coordinate installation of underground raceways with other outside and building construction work. Maintain existing outside utilities in operation unless otherwise authorized by the Engineer.

3. Remove entirely and properly reinstall all raceway installations not in compliance with these requirements.

4. Union type fittings shall not be used in underground installation.

5. Provide a minimum cover of 24-inches over all underground direct buried raceways or top of concrete encasement envelope unless otherwise indicated on the Drawings.

6. Concrete encasement and/or backfill of underground raceways shall not commence until inspected by the Engineer.

7. Warning Tape: Bury warning tape approximately 12 inches below finished grade. Align parallel to and within 6 inches of the centerline of runs that are 2 feet wide or less. Provide two tapes and align parallel to and within 6 inches of the centerline of each side of runs that are more than 2 feet wide.

8. Perform bends in raceways as follows:

a. Except at conduit risers, accomplish changes in direction of duct runs exceeding a total of 10 degrees, either vertical or horizontal, by long utility duct sweep bends having a minimum radius or curvature of 12-1/2 feet; utility duct sweep bends may be made up of one or more curved or straight sections or combinations thereof.

b. For direct buried conduit, accomplish changes in direction runs exceeding a total of 10 degrees, either vertical or horizontal by using 5 degree PVC-40 couplings.

c. At conduit risers use manufactured bends having a minimum radius of 36 inches for ducts of 3 inches in diameter and larger.

9. Install conduit seals in below grade core drilled openings or cast conduit sleeves as shown on the Contract Documents and per the submitted conduit penetration sealing submittal.

10. Plug spare raceways and seal them watertight at all handholes, buildings and structures.

11. Raceways installed under slab floors shall lie completely under the slab with no part of the horizontal run of the raceway embedded within the slab. Raceway shall be a minimum of 4” below the building or equipment slab.

12. Install concealed, embedded, and buried raceways so that they emerge at right angles to and flush with the finished surface. None of the curved portion of the bend shall be exposed at the entry point.

13. Raceway terminations at handholes shall include end bell connectors for PVC conduit.

14. Patch all duct knockouts and openings in handholes with non-shrink grout.

B. Separation and Support:

1. Separate runs of two or more parallel raceways in a single trench with preformed, nonmetallic spacers designed for the purpose. Install spacers at intervals not greater than that specified in the NEC for support of the type raceways used, and in no case greater than 5 feet.

2. Support raceways installed in fill areas to prevent accidental bending until final concrete is set or backfilling/compaction is complete. Tie raceways to supports, and raceways and supports to the ground, so that raceways will not be displaced when concrete encasement or earth backfill is placed.

3. When separate parallel duct banks are shown on the Drawings, provide a minimum horizontal separation between the parallel runs.

a. Power ductbank (over 100 Volts ground): Provide nominal 48-inch horizontal separation between adjacent duct bank sides or as much as allowable by the physical constraints of the site.

b. Signal ductbank (less than 100 Volts to ground): Provide nominal 24-inch horizontal separation between adjacent duct bank sides or as much as allowable by the physical constraints of the site.

C. Arrangement and Routing:

1. Arrange multiple conduit runs substantially in accordance with applicable details shown on the Drawings. Locate and route underground conduits as indicated on the Drawings.

2. Make minor changes in location or cross section as necessary to avoid obstructions or conflicts. Where raceway runs cannot be installed substantially as shown because of conditions not discoverable prior to digging of trenches, inform the Engineer for resolution before continuing with the work. Determine precise ductbank alignment and depth as required to avoid other utilities, structures, or features.

3. Where piping systems are encountered by means of potholing or installed under this Contract along a ductbank route, maintain a 12-inch minimum vertical separation between raceways and other systems at crossings. Do not place raceways over valves or couplings in other piping systems. Refer conflicts with these requirements to the Engineer for instructions before continuing with the work.

4. Duct bank alignments shown on Drawings are diagrammatic. Actual alignments shall contain no sharp bends and shall be installed with long sweep bends. In no case shall minimum radius bends exceed values as defined in the NEC.

5. In multiple conduit runs, stagger raceway coupling locations so that couplings in adjacent raceways are not in the same transverse line.

6. Flare out incoming duct bank raceways at building walls or other structures sufficient to allow installation of conduit seals and sleeves with separation as recommended by the manufacturer. Coordinate core drill or conduit block-out locations for conduit entrances with the Structural Drawings.

D. Concrete Encasement:

1. Encase conduits in a red reinforced concrete envelope as indicated on the Drawings. Minimum reinforcement steel and concrete envelope shall be provided as shown on the Drawings. Concrete for ductbank encasement, where required, shall be at least 2,500 psi concrete with 1-inch maximum aggregate conforming to the requirements of Section 03305.

2. Maintain a grade of at least 4 inches per 100 feet, either from one handhole to the next, or from a high point between them, depending on the surface contour. Install raceways to drain away from buildings.

3. Hold conduits for concrete encased raceways securely in place by acceptable window type spacer supports as specified. Where, in the opinion of the Engineer, ground conditions are such as to require concrete forms, install forms constructed of materials and in a manner acceptable to the Engineer. No variations greater than 12-inches in 50 feet will be permitted from a straight line.

4. Envelopes may be poured directly against the sides of trenches if the cut is clean, even, and free of loose material. Remove loose material from trenches before and during pouring of concrete to ensure sound envelopes. Carefully spade concrete during pouring to eliminate all voids under and between raceways and honeycombing of the exterior surface.

5. Do not use power driven tampers or agitators unless they are specifically designed for the application to ensure that the watertight integrity of the raceways is maintained.

6. Pour an entire concrete envelope in one continuous pour. Where more than one pour is necessary, terminate each pour in a sloped plane, and insert 3/4 inch reinforcing rod dowels extending into the concrete 18 inches minimum on each side of the joint. Obtain Engineer's approval for the number and location of dowels.

7. Where connections to existing duct lines are indicated, remove existing cables which constitute interference with the work. Excavate the lines to the maximum depth necessary. Cut off the lines and remove loose concrete from the ducts before new concrete encased ducts or handholes are installed. Provide a reinforced concrete collar, poured not less than 5-feet along the new duct line, to take the shear at the joint of the duct lines. Abandon in place those disused ducts and cables which do not interfere with the work.

E. Backfill Installation above Concrete Envelope of Concrete Encased Conduit:

1. Backfill material above concrete envelope of concrete encased conduit may be selected from the excavated material if it contains no particles larger than 3 inches in diameter and is free from roots or debris in conformance with Division 2. Imported material meeting these same requirements may be used in lieu of material from the excavation. Compact backfill in maximum 12 inch layers to at least 95 percent of the maximum density at optimum moisture content as determined by AASHTO T 180 and as specified in Division 2.

3.4 INSTALLATION REQUIREMENTS FOR HANDHOLES

A. Install handholes and accessories as shown on the Drawings and per the manufacture's recommendations.

B. Final ductbank, handhole, and other structure locations and depths vary based on installed depths and underground conditions. Set handholes and other structures at the proper elevation such that the slope of raceways shall be towards handholes and away from structures, vaults and buildings.

C. Provide synthetic rubber expansion joint material around duct bank envelopes at entry point to structures or handholes. Fill gaps at expansion joint between duct bank and structure or handhole with synthetic rubber sealing compound.

D. For duct or conduit line connections to existing handholes or splice boxes, core drill or break the handhole or splice box wall out to the dimensions required. Preserve the steel in the wall. Provide epoxy dowels into the existing concrete of the handhole or splice box and backfill with concrete to achieve unitized construction.

E. Unless shown otherwise on the Drawings, the handholes shall be laid on a minimum of 12” thick crushed rock base. Install structures flush with the final finished surface in paved areas and a nominal 3-inches above the final graded surface in non-paved or landscaped areas as shown on the Drawings. Install extension rings as necessary to establish the specified elevation of the handhole top with the finished grade.

F. Install pulling-in irons anchored to the concrete and opposite all raceway entrances to handholes.

G. Install cable racks on opposing wall faces on each handhole. Install cable racks along the long dimension of handhole, anchored in accordance with the manufacturer’s requirements.

H. Install sump pumps where shown on the Drawings in the box sump. Where no sump pump is provided, break out the concrete at the bottom of the box sump to act as a drain.

I. Clean and remove any excess concrete, asphalt, dirt of other material to ensure that handhole tops, lids and hatches are flush to the surface, unobstructed, and can be fully open for access. Handhole tops that are damaged, cracked, bent, or “sprung” (inoperable spring assist cover) shall be replaced at the completion of the project at no additional cost to the City.

J. Handhole top identification lettering shall be clear and fully legible at the completion of the project.

3.5 PREPARATION FOR PULLING IN CONDUCTORS

A. Do not install crushed or deformed raceways. Avoid traps in raceways. Take care to prevent the lodging of plaster, concrete, dirt, or trash in raceways, boxes, fittings, and equipment during the course of construction. Make raceways entirely free of obstructions or replace them. Ream all raceways, remove burrs, and clean raceway interior before introducing conductors or pull wires.

B. Immediately after installation, plug or cap all raceway ends with watertight and dust-tight seals until the time for pulling in conductors.

C. For concrete-encased raceways (after the concrete envelope has set), and for direct buried conduits, pull a mandrel through each raceway to remove debris. Pull a mandrel of a diameter approximately 1/4 inch less than the raceway inside diameter, through each raceway. Use cleanout or flexible mandrels for conduit sizes greater than 2-inches; use rubber/foam mandrel for conduit sizes 2-inches and below.

D. For all raceways which contain less than 50 percent of the NEC allowed fill of control cables or individual conductors, install a nylon pull rope with the conductors.

E. Unless otherwise shown on the Drawings, install conductors in lower layers of conduits in handholes leaving upper layers of conduits as spares for future conductor installations.

F. Install plastic cable spacers or shoes on cable racks for supporting and tying off cables pulled into the structures.

G. Installation of conductors shall conform to the requirements of Section 16120 and Section 16121 as applicable.

3.6 EMPTY RACEWAYS

A. Certain raceways will have no conductors pulled in as part of this Contract. Identify with conduit tags at each end and at any intermediate pull point of each such empty raceway. Provide a fabricated, listed removable cap over each end of empty raceways. Provide a nylon pull rope with a minimum of 3-feet of slack at each end in each empty raceway. Provide cap with eyelet for attaching the nylon pull rope.

3.7 CABLE DUCT SHIELDS

A. Provide shields where cables enter and leave handholes and other entrances. Shields shall be of a suitable type manufactured for protecting the cable from abrasion or other damage.

3.8 FIELD PAINTING

A. Clean cast-iron frames and covers not buried in masonry or mortar of mortar, rust, grease, dirt, and other deleterious materials, and give a coat of bituminous pain. Clean steel frames not buried in masonry and steel covers of mortar, dirt, and grease by an approved blasting process. Clean surfaces that cannot be cleaned satisfactorily by blasting process. Clean surfaces that cannot be cleaned satisfactorily by blasting by wire brushing or other mechanical means to bare metal. Wash surfaces contaminated with rush, dirt, oil, grease, or other contaminants with solvents until thoroughly cleaned.

B. Immediately after cleaning, coat surfaces with a pretreatment coating or give a crystalline phosphate coating.

C. As soon as practicable after the pretreatment coating has dried, prime treated surfaces with a coat of zinc chromate primer and one coat of synthetic exterior gloss enamel as described in Division 9.

3.9 IDENTIFICATION

A. Provide engraved conduit identification tags at each underground structure as specified in Section 16130.

3.10 RECONDITIONING OF SURFACES

A. Restore paved and unpaved surfaces disturbed during the installation of duct or conduit to their original elevation and condition in accordance with Division 2.

END OF SECTION

SECTION 16910 – FIRE DETECTION AND ALARM SYSTEMS

PART 1 GENERAL

1.1 SUMMARY

A. A single Fire Alarm System Supplier (FASS) shall furnish all materials, equipment, labor, and services required to achieve a fully integrated and operational Fire Alarm System which shall be in complete compliance with the NFPA Class and Style as specified in these Specifications. The Fire Alarm System shall be an analog addressable type system.

B. The FASS shall complete the conceptual design as detailed on the Drawings in full compliance with applicable sections of the NFPA 72, NFPA 70, NFPA 79, Americans with Disabilities Act, and City of Brentwood Fire Department requirements.

C. The Drawings and Specifications are not intended to be a complete listing of all components required for the system. Location and type of area smoke detectors as shown on Drawings are approximate only. The FASS shall locate and provide the applicable smoke sensor type as required by the physical environment of the area and the NFPA.

D. All auxiliary and accessory equipment necessary for system performance in compliance with the applicable codes shall be provided even if not specifically detailed on the Drawings or in these Specifications.

E. Preparation and submittal of detailed, project specific installation drawings (including but not necessarily limited to mounting, interconnection, wiring type details, supportive calculations, etc.) shall be included as a part of this work. This includes preparation of drawings and information, submittal, discussions, testing, repairs and retests, and coordination needed to secure approvals and permit from the City of Brentwood Fire Department.

F. Contractor shall pay all permit and inspection fees as Contract work.

G. The FASS shall coordinate the Fire Alarm System with other related equipment and materials furnished by other suppliers under other sections of these Specifications.

H. The FASS shall ensure that all equipment of the system is furnished, installed, and connected in accordance with the manufacturer's instructions and the regulations of the City of Brentwood Fire Department.

I. The fire alarm system at the Brentwood WWTP is existing and shall be expanded to include additional monitoring points as required per Section 15310 and shown on the Drawing. The existing fire alarm control panel is a Radionics (Bosch) D9412G that shall be reconfigured for monitoring the additional points shown on the Contract Documents. Partial system documentation for the existing system is included in Appendix 16910-A. Additional available documentation will be provided following Notice of Award.

1.2 RELATED SECTIONS

A. Section 15310 – Fire Protection Piping and Valves

B. Section 16000 – Common Work Results for Electrical

C. Section 16120 – Conductors and Cables (600V Volt Maximum)

D. Section 16122 – Fiber Optic Cables and Equipment

E. Section 16130 – Raceways, Boxes, Fittings and Supports

1.3 SUBMITTALS

A. Shop drawings shall be in accordance with Section 01340 and Section16000. As a minimum, the shop drawings and instructions shall include the following:

1. Complete wiring diagrams.

2. Operational details for the modifications

3. Point-to-point wiring diagrams

4. Complete conduit interconnection diagrams (conduit riser diagrams) including proposed routing and labeling of all conduits for the system.

5. Calculations for conduit size and fill based on the NEC and manufacturer's recommendations.

6. Calculations for circuit loading confirming maximum individual circuit loading is below 80% of rating.

7. Calculations for battery sizing confirming adequacy of the existing batteries or new batteries provided under this Contract as specified to accommodate the additional devices and sensors added under this Contract.

B. Shop drawings shall contain information to verify State Fire Marshal acceptance of each device.

C. Shop drawings, product information, calculations, and other regulatory required information shall be submitted to, and approved by, the City of Brentwood Fire Department after submittal to the Engineer. Verification of approval shall be submitted to the Engineer with the fire alarm system shop drawings. Submit a copy of the permit application and receipts for all required fees showing evidence of payment.

D. Field Acceptance Test Submittal

1. A system field acceptance test submittal shall be prepared by the FASS for review by the Engineer. The submittal shall consolidate and organize the testing requirements and results for all components in the system.

2. A test summary tabulation shall be provided for each switch or control function in the Project. The tabulation shall include the following as a minimum:

a. Room/area number with a separate line for each device and control/reporting function.

b. Physical installation check-off box for each device and control/reporting function.

c. Functional check-off box for each device and control/reporting function.

d. Full acceptance check-off box for each device and control/reporting function.

e. Comments box for each device switch and control/reporting function.

1.4 REFERENCE STANDARDS

A. Work under this Section shall conform to:

1. NFPA 70 – National Electrical Code.

2. NFPA 72 – National Fire Alarm Code.

3. NFPA 79 – Electrical Standard for Industrial Machinery.

4. NFPA 101 – Life Safety Code

5. ADA – Americans with Disabilities Act (Federal and State laws).

6. Applicable City of Brentwood Fire Department Code revisions and regulations.

7. Underwriters Laboratories Inc.: All equipment shall be approved by Underwriters Laboratories, Inc. for its intended purpose, listed as power limited by Underwriters Laboratories, Inc.

1.5 QUALITY ASSURANCE

A. The FASS shall be Bosch Security Systems or no equal, to match existing City system components and installations.

B. Physical installation of the fire alarm system need not be performed by the FASS's employees; however, the FASS as a minimum shall be responsible for the technical supervision of the installation by providing on site supervision to the installers of the system.

C. Being listed in this specification section does not relieve the FASS from meeting the qualifications and performance requirements as specified in this Section.

D. Where such listings exist, all items of the Fire Alarm System shall be listed as a product of a single fire alarm system manufacturer under the appropriate category by Underwriters' Laboratories, Inc. (UL), and shall bear the corresponding "U.L." label.

E. All materials shall be listed by UL, NFPA, and the State Fire Marshal wherever standards have been established by those organizations.

F. When more restrictive requirements have been adopted by the local authority having jurisdiction, the system shall comply with the local requirements.

G. All installation drawings, calculations, and other shop drawings developed for this installation as required by the City of Brentwood shall be stamped and signed by a licensed Fire Protection Engineer registered in the State of California.

1.6 SYSTEM DESCRIPTION

A. The system shall have as a minimum the components as shown on the Drawings and as specified in these Specifications. Additional components shall be supplied as required to comply with NFPA 70, NFPA 72, NFPA 79, and the City of Brentwood Fire Department at no additional cost to the City.

B. Additional points shall be incorporated into the existing FACP including:

1. Biosolids/Dryer Building fire alarm system initiation devices – detection devices, audible/visual devices, and manual pull stations

2. Biosolids/Dryer Building fire protection piping tamper switch

3. Biosolids/Dryer Building fire protection water flow switch

4. Biosolids Storage area fire alarm audible/visual device

5. Biosolids Storage area fire protection piping tamper switch

6. Biosolids Storage area fire protection piping flow switch

C. Activation of either of these devices shall be monitored and alarmed in the existing system matching the existing alarm protocol.

D. System malfunction (supervisory circuit, sensor failure, etc.) shall be indicated as alarms at the existing Central FACP but shall not actuate the building alarm indicating appliances.

E. The system (including all initiating devices, notification appliances and signaling line circuits) shall be consistent with the requirements of a Class B system as defined in NFPA 72.

F. The system shall send individual addressed fire alarm signals to the FACP.

1.7 FINAL DOCUMENTATION

A. The FASS shall submit the following final documentation prior to final acceptance of the system per Section 01730.

1. As-built documentation of the Fire Alarm System.

2. Hardware Maintenance Documentation.

B. The final documentation shall be new documentation written specifically for this Work, but may include standard and modified standard documentation. All standard documentation furnished shall have all portions that apply clearly indicated. All portions that do not apply shall be lined out.

C. The documentation shall contain all illustrations, detailed drawings, wiring diagrams, and instructions necessary for installing, operating, and maintaining the equipment. The illustrated parts shall be numbered for identification. All information contained shall apply specifically to the equipment furnished and shall only include instructions that are applicable. All such illustrations shall be incorporated within the printing of the page to form a durable and permanent reference document.

D. The requirements for the final documentation are as follows:

1. As-built documentation shall include all previous submittals, as described in this Specification, updated to reflect the as-built system. Any errors in or modifications to the system resulting from the Field Acceptance Tests shall be incorporated in this documentation. As-built Drawing documentation shall include as a minimum; the following information:

a. Field wiring color code and identification tag.

b. Field wiring termination points.

PART 2 PRODUCTS

2.1 FIRE ALARM SYSTEM GENERAL REQUIREMENTS

A. Provide and integrate new initiation devices, sensors, notification devices, expansion modules, and other equipment into existing FACP as shown on Drawings or as required by the manufacturer for a fully functioning and operational expanded system.

B. Submit updated battery calculation confirming adequacy of the existing batteries or size of new batteries required to power the existing and new sensors, actuating devices, notification devices, expansion modules, and other equipment provide under this Contract. If the existing battery supply is inadequate to serve the revised system, provide new battery supply under this contract based on the results of the submitted calculations.

C. The FACP shall automatically test all new smoke detectors in compliance with NFPA stands to ensure that they are within listed sensitivity parameters.

D. Provide tamper switch and flow switch components as specified herein and in Section 15310.

2.2 ADDRESSABLE EXPANSION MODULE

A. Provide addressable expansion module as required.

B. The expansion module shall support up to 238 additional devices.

C. The expansion module shall be mounted inside the power supply cabinet or in a new approved enclosure as determined by the FASS. The module shall be Bosch Security System model D8125, no equal, to match existing City fire alarm system components.

2.3 INITIATING DEVICES

A. Addressable Pull Stations (Manual Fire Alarm Boxes)

1. Pull stations shall be double action breakglass/pull type and identified with "FIRE ALARM" in raised white lettering. Pull stations shall be manufactured from high impact red Lexan. The station shall mechanically latch upon operation and remain so until manually reset by opening with a key.

2. The front of the station shall be hinged to a backplate assembly and require a key to reset the station. Provide common keying with the control panels. Stations which use Allen wrenches or special tools to reset will not be accepted.

3. The addressable manual station Bosch Security System model FMM-462 with Popit, no equal, to match existing City fire alarm system components.

B. Addressable Area Smoke Sensors

1. The addressable area smoke sensors shall be of the two-piece type consisting of a base and removable sensor head. Sensors shall be suitable for mounting on approximately 30 ft. spacings.

2. The sensor head shall be of the photoelectric type and provided with insect screens and enclosed backs to minimize dust entry. The head shall be easily removed from the base for replacement or maintenance cleaning.

3. The sensors shall be listed to UL Standard 268 and shall be documented as compatible with the control equipment to which they are connected. The sensors shall be listed for both ceiling and wall mount applications.

4. Each sensor base shall contain a LED that provides visual indication of power on and alarm. The LED shall turn on steady indicating the alarm condition and flash to indicate power on.

5. Each sensor shall contain a magnetically actuated test switch to provide for alarm testing at the sensor location.

6. The sensor's electronics shall be immune from false alarms caused by EMI and RFI.

7. Each sensor shall include an automatic smoke detector cleaning indication.

8. Shall comply with the NFPA 72 sensitivity test requirements.

9. The addressable area smoke detector shall be Bosch Security System model F220 with F220-B6PS, no equal, to match existing City fire alarm system components.

C. Addressable Heat Detectors – NOT USED

D. Addressable Reflected Beam Smoke Detectors

1. Addressable beam detectors shall be single-ended, reflective design with a transmitter/receiver unit and a reflector. Detectors shall be suitable for mounting at approximately 60 feet spacing and provide open area protection.

2. Detectors shall come equipped with an integral sensitivity test feature and furnished with a remote test station. Unit shall offer protection within a minimum 16-328 ft. range. Detector shall have an adjustment angle of +/- 10 degrees both horizontally and vertically.

3. Detectors shall have status LEDs for alarm, trouble, and standby. Unit shall have adjustable sensitivity selections.

4. Beam detectors shall be surface mountable. Accessories required for surface mounting shall be provided.

5. Provide Bosch Security System model D297 with POPIT, no equal, to match existing City fire alarm system components.

E. Addressable Duct Smoke Detectors

1. Provide addressable duct smoke detectors that will be compatible with the existing FACP. The duct smoke detector shall be monitored and shall be provided with 24VDC.

2. The duct smoke detectors shall be Bosch Security System model D341P, no equal, to match existing City fire alarm system components.

2.4 NOTIFICATION DEVICES

A. Audio/Visual Alarm Indicating Appliance

1. Audio/Visual units shall provide a common enclosure for the fire alarm audible and visual alarm devices. The device shall be furnished with an electronic horn (95 dB at 10 foot) and a xenon flash (100 candela - seconds and 1 to 1.5 flashes per second). The unit shall be complete with a tamper resistant, pyramid shaped Lexan lens with "FIRE" lettering visible from a 180° field of view. The lamp assembly shall incorporate a built-in reflector and include shock-mounting to resist bulb failure due to vibration. Unit shall be complete with all mounting hardware including backbox.

2. Indoor rated audio/Visual Appliances shall be Bosch Security System W-HSR, or no equal, to match existing City fire alarm system components.

3. Outdoor rated audio/Visual Appliances shall be Bosch Security System ASWP-247W-FR, or no equal, to match existing City fire alarm system components.

B. Visual Flashing Lamps (Xenon Strobe)

1. Visual indicating appliances shall be comprised of a Xenon flashtube rated 100 candelas - seconds and 1 to 1.5 flashes per second and pyramid shaped Lexan lens with "FIRE" lettering visible from a 180° field of view. The lamp assembly shall incorporate a built-in reflector and a shock-mounting to resist bulb failure due to vibration. These devices shall be suitable for either ceiling or wall mounting.

2. Visual flashing lamps shall be Bosch Security System W-STR, no equal, to match existing City fire alarm system components.

C. Alarm Beacon – NOT USED

2.5 MISCELLANEOUS COMPONENTS

A. Mounting Boxes

1. Provide surface or flush mount boxes for all devices. Boxes shall be surface mount in unfinished areas and flush mount in finished areas. Boxes shall conform to Section 16130.

B. Conduit, Wire and Cable

1. The FASS shall be responsible for specifying the exact type, quantity, size, and location of all conduit, cable and wire for the fire alarm system.

2. Conduit shall be in conformance with Section 16130.

3. All wire and cable shall be underground rated.

4. All system wiring shall be in accordance with the requirements of NFPA 70, the National Electrical Code (NEC) and comply with Article 708 and Article 760 of the NEC including requirements for minimum 2-hour fire rating.

PART 3 EXECUTION

3.1 INSTALLATION

A. Conduit and wire requirements are not shown on the Drawings. The system shall be wired in conduit throughout (except where noted otherwise) in accordance with the manufacturer's diagrams and requirements, the system riser diagram shown on the Drawings, the remainder of Division 16 Specifications, and submittal data.

B. Final connections in the fire alarm system shall be made by or under the direct supervision of an authorized representative of the FASS. Upon completion of the installation and testing as specified in these Specifications, the FASS shall check, test, and confirm operational the entire system with a representative of the City of Brentwood Fire Department and the Engineer present.

C. All components shall be mounted at spacings and heights as detailed in NFPA 72 and ADA.

3.2 MANUFACTURER'S SERVICE DURING INSTALLATION

A. Supervision: Check and certify the installation of all components before power is applied.

B. Check Out: Place the equipment into operation and making necessary adjustments.

C. Instruction: Provide instruction of plant personnel in the operation and maintenance of all equipment of the system as required per Section 01758.

3.3 CORRECTION OF DEFICIENCIES

A. All deficiencies in work and/or items not meeting specified testing requirements shall be corrected to meet specification requirements at no additional cost.

3.4 TESTS

A. The approved Field Acceptance Test Binder shall form the basis of the documentation of the system acceptance tests. All acceptance tests shall be witnessed by and signed off by the Engineer, the FASS's field engineer, the installing contractor, and a representative of the City of Brentwood Fire Department. A functional final testing of the fire alarm system is required to be witnessed by the City of Brentwood Fire Department.

B. The FASS shall furnish the services of a field service engineer, and any special tools, equipment, and labor to perform the tests.

C. The Engineer and the City of Brentwood Fire Department shall be notified in writing a minimum of two weeks prior to the scheduled day for the field acceptance tests. The testing schedule shall be as acceptable to the Engineer.

D. Each device and control function shall be individually witness tested and recorded in the Field Acceptance Test Submittal. Two certified copies of the test submittals shall be furnished.

3.5 TRAINING

A. Provide operations and maintenance training, including both classroom and hands-on training of the Fire Alarm System in accordance with Section 01660.

END OF SECTION

APPENDIX 16910-A

CITY OF BRENTWOOD WWTP

EXISTING FIRE ALARM SYSTEM DOCUMENTATION

The fire alarm system at the Brentwood WWTP is existing and shall be expanded to include additional monitoring points as required per Section 15310 and shown on the Drawing. The existing fire alarm control panel is a Radionics (Bosch) D9412G that shall be reconfigured for monitoring the additional points shown on the Contract Documents. Partial system documentation for the existing system is included in Appendix 16910-A. Additional available documentation will be provided following Notice of Award.

ADT SECURITY

Alarm Company Operator: ACO 4227 EXP. 2/03
California Contractors License: C7& C10 #707408 Exp. 5/31/03

FIRE & SECURITY ALARM SUBMITTAL

System Location:

Brentwood WWTP
City of Brentwod
Brentwood, Ca

Installing Company:

ADT Securty
4725 Entrprise Way
Modesto, CA 95356
(209) 574-2733

00405 FA REV

RECEIVED
MAR 29 2002
CONTRA COSTA

INDEX:

1. BATTERY CALCULATIONS
2. VOLTAGE DROP CALCULATIONS
3. LEGEND
4. RISER DIAGRAM
5. SEQUENCE OF OPERATION
6. GENERAL NOTES
7. EQUIPMENT CUT SHEETS
8. C.S.F.M. SHEETS
9. WIRING DIAGRAMS

TO REQUEST FIELD INSPECTIONS CONTACT FIRE DISTRICT TWO WORKING DAYS IN ADVANCE, AT 925-930-5540

ADT SECURITY SERVICES INC.
STATE OF CALIFORNIA
LICENSED ELECTRICAL CONTRACTOR
ACO # 4227
C7/C10 # 707408
EXPIRES: 5/31/03
SIGNED:
DATE: 3/12/02

CONTRA COSTA COUNTY
FIRE PROTECTION DISTRICT
2010 GEARY ROAD
PLEASANT HILL, CA 94523-4694

ADT SECURITY

Alarm Company Operator: ACO 4227 EXP. 2/03
California Contractors License: C7& C10 #707408 Exp. 5/31/03

FIRE & SECURITY ALARM SUBMITTAL

System Location:

Brentwood WWTP
City of Brentwod
Brentwood, Ca

Installing Company:

ADT Securty
4725 Entrprise Way
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SUBMITTAL REVIEW
REVIEW IS FOR GENERAL COMPLIANCE WITH CONTRACT DOCUMENTS
NO RESPONSIBILITY IS ASSUMED FOR CORRECTIONS OF DIMENSIONS OR DETAILS

NO EXCEPTIONS TAKEN	
MAKE CORRECTIONS NOTED	✓
AMEND & RESUBMIT	
REJECTED - SEE REMARKS	

G. S. DODSON & ASSOC.
Consulting Engineers
Date 4.10.02 By BR
See comments

ADT SECURITY SERVICES INC.
STATE OF CALIFORNIA
LICENSED ELECTRICAL CONTRACTOR
ACO # 4227
C7/C10 # 707408
EXPIRES: 5/31/03
SIGNED:
DATE: 3/15/02

Battery Calculations:

For: Brentwood WWTP
City of Brentwod
Brentwood, Ca

Quantity	Components	Stand-by Each	Stand-by Total	Alarm Each	Alarm Total	
FIRE ALARM EQUIPMENT:						
1	Radionics D1255 Keypad	104	104	206	206	
1	Radionics D928 Phone Module	14	14	45	45	
1	Radionics D192C Bell Module	15	15	50	50	
13	Radionics D285TH Smoke Detect	0.08	1.04	15	195	
13	Radionics D288 Base	0.055	0.715	56	728	
8	Radionics D559S Horn/Strobe	0	0	0	0	***
7	Radionics D545S Strobe	0	0	0	0	***
1	Radionics D9412 Control	250	250	500	500	
1	Radionics D8129 OctoRelay	20	20	320	320	
1	Radionics D8125 Popex Module	50	50	50	50	
21	Radionics D9127 Popit Module	5	105	5	105	
7	Radionics D461 Manual Pull	0	0	0	0	
4	Radionics D126 Battery	0	0	0	0	
1	Waterflow Switch	0	0	0	0	
3	Tamper Switch	0	0	0	0	
2	Duct Detector (Tie-down Only)	0	0	0	0	
2	Radionics D411 Sync Module	25	50	25	50	
4	FSD (Tie-down Only)	0	0	0	0	
1	Radionics Aux Power Supply	110	110	110	110	
SECURITY EQUIPMENT:						
13	Sentrol 2507A Contact	0	0	0	0	
			0		0	
	Subtotal in Milliamps		719.755		2359	
	Subtotal in Amps		0.72		2.36	
			x24 Hours		x.084 Hours	
	Subtotal Amps Needed		17.27		0.20	
	Total Amps Needed		17.47			

Battery Installed:	28 Amp/Hours
Reserve:	10.53 Amp/Hours

*** Powered By Aux Power Supply at FACP

3/12/2002

Voltage Drop Calculations

For: Brentwood WWTP
City of Brentwod
Brentwood, Ca

Formula used for each bell circuit:
Voltage Drop = (Distance x 2) x (wire resistance per ft) x (current draw (miliamps/1000) for last device)
Distance = one way wire length from control to last device.
Wire resistance = ohms per foot (see wire resistance table).
Current draw = current in amps needed for the last device.

Resistance of Standard Copper Wire.

Wire Gage	ohms per foot
10	0.00102
12	0.00162
14	0.00258
16	0.00409
18	0.00651
20	0.0104
22	0.0165
24	0.0262

Voltage Drop Calculations 24 Volts (Panel voltage)

	Distance	Wire Gauge	Resistance	Current	Voltage Drop	% Drop
Bell Circuit #1:	96	12	0.00162	0.432	0.134	0.56%
Bell Circuit #2:	126	12	0.00162	0.474	0.194	0.81%
Bell Circuit #3:	180	12	0.00162	0.302	0.176	0.73%

Total Current Draw Per Bell Circuit

	Qty	Device	Current (ma) per device	Current (amps) Total Draw	
Bell Circuit #1:	2	Horn/Strobe	86	0.172	
	4	Strobe	65	0.26	0.432 AMPS
Bell Circuit #2:	4	Horn/Strobe	86	0.344	
	2	Strobe	65	0.13	0.474 AMPS
Bell Circuit #3:	2	Horn/Strobe	86	0.172	
	2	Strobe	65	0.13	0.302 AMPS

Total Current Used: 1.208 AMPS

Current Available 6 AMPS

SYSTEM INSTALLED TO N.F.P.A. SPECIFICATIONS AND APPLICABLE LOCAL CODES

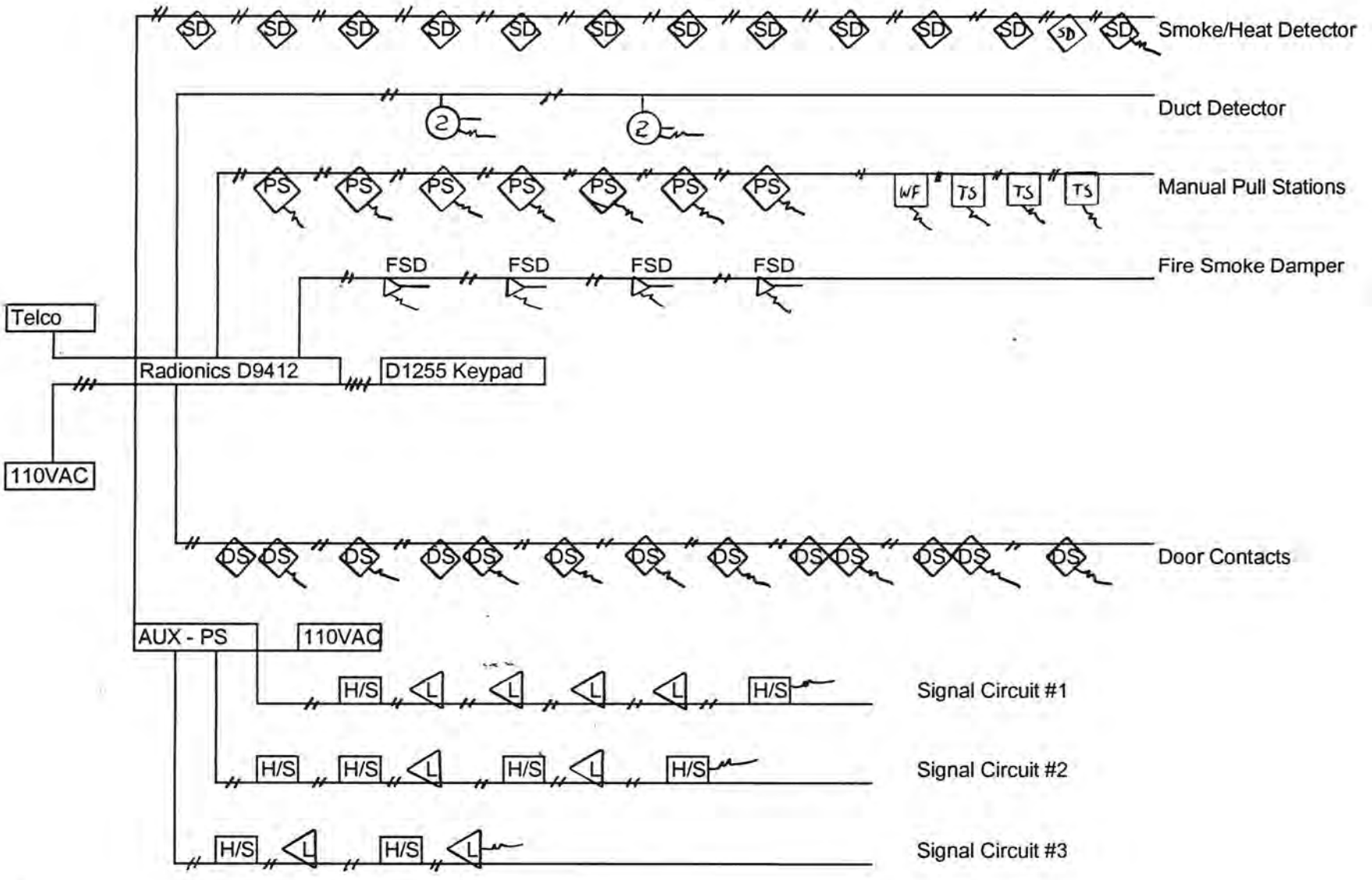
3/12/2002

LEGEND

For: Brentwood WWTP
City of Brentwod
Brentwood, Ca

QUANTITY	SYMBOL	EQUIPMENT/MODEL#	MODEL #	CFM#	EXP DATE
1	KP	Radionics D1255 Keypad	D1255	7165-0801:123	6/30/2002
1	FACP	Radionics D928 Phone Module	D928	7165-0801:123	6/30/2002
1	FACP	Radionics D192C Bell Module	D192A	7165-0801:123	6/30/2002
13	SD	Radionics D285TH Smoke Detecto	D285TH	7272-0801:162	6/30/2002
13		Radionics D288 Base	D293A	7300-0801:161	6/30/2002
8	H/S	Radionics D559S Horn/Strobe	D559S	7125-0801:178	6/30/2002
7		Radionics D545S Strobe	D545S	7125-0801:180	6/30/2002
1	FACP	Radionics D9412 Control	D9412	7165-0801:123	6/30/2002
1	FACP	Radionics D8129 OctoRelay	D8129	7165-0801:123	6/30/2002
1	FACP	Radionics D8125 Popex Module	D8125	7165-0801:123	6/30/2002
21		Radionics D9127 Popit Module	D9127	7165-0801:123	6/30/2002
7	PS	Radionics D461 Manual Pull	D461	7150-0801:113	6/30/2002
4	FACP	Radionics D126 Battery	D126	7165-0801:123	6/30/2002
1	WF	Waterflow Switch	VSR-D	7770-0328:001	6/30/2002
3	TS	Tamper Switch	PIVS-B	7770-0328:010	6/30/2002
2	S	Duct Detector (Tie-down Only)			6/30/2002
2	AUX	Radionics D411 Sync Module	D411	7300-0801:157	6/30/2002
4	FSD	FSD (Tie-down Only)			6/30/2002
1	AUX	Radionics Aux Power Supply	D9142F	7315-0801:155	6/30/2002
13	DS	Sentrol 2507A Contact	2507A		
0		0			

RISER DIAGRAM -OPERATIONS BUILDING



SEQUENCE OF OPERATION:

DEVICE	SYSTEM RESPONSES			
	GEN. ALARM	CENTRAL STN	TROUBLE	SUPERV.
	LOCAL		LOCAL	LOCAL
Smoke Detector	X	X		
Manual Pull Station	X	X		
Heat Detector	X	X		
Duct Detector		X	X	X
Waterflow Switch	X	X		
Tamper Switch	X	X		
Indicating Circuit Trouble		X	X	
Initiating Circuit Trouble		X	X	
Primary Power Touble		X	X	
Secondary Power Trouble		X	X	
Fire Smoke Damper	X	X		
Door Contact		X		

GENERAL NOTES:

1. THE FIRE ALARM SYSTEM SHALL CONFORM TO ARTICLE 760 OF NEC 1998, CFC 1998, NFPA 72 1996.
2. UPON COMPLETION OF THE INSTALLATION OF THE FIRE ALARM SYSTEM, A SATISFACTORY TEST OF THE ENTIRE SYSTEM SHALL BE MADE IN THE PRESENCE OF THE FIRE MARSHAL.
3. A MINIMUM OF 48 HOURS NOTICE SHALL BE REQUIRED FOR ANY INSPECTION AND/OR TESTING.
4. ALL DEVICES OF THE FIRE ALARM SYSTEM SHALL BE APPROVED AND LISTED BY THE CALIFORNIA STATE FIRE MARSHAL.
5. A STAMPED SET OF APPROVED FIRE ALARM PLANS SHALL BE ON THE JOB SITE AND USED FOR THE INSTALLATION. ANY DEVIATION FROM APPROVED PLANS, INCLUDING THE SUBSTITUTION OF DEVICES, SHALL BE APPROVED BY THE FIRE MARSHAL.
6. ANY DISCREPANCIES BETWEEN THE DRAWINGS AND THE CODE OR RECOGNIZED STANDARDS SHALL BE BROUGHT TO THE ATTENTION OF THE INSPECTOR OF RECORD.
7. A CERTIFICATE OF COMPLIANCE SHALL BE PREPARED BY THE INSTALLER AND GIVEN TO THE FIRE MARSHAL UPON COMPLETION OF THE INSTALLATION.
8. SECURITY DEVICES ARE SHOWN FOR BATTERY CALCULATIONS

PROJECT SCOPE:

Local Manual and Automatic Fire Alarm System

Occupancy Classification: B

Building is Sprinklered

System Design and Installation by:

ADT Security Systems
4725 Enterprise Way #5
Modesto, CA 95356

Designer: Gerry Adams (209) 574-2733

Installation Manager: Albert Martinez (209) 574-2742

System Installation Standards: NFPA 72, 1996, NEC 1998, CEC 1998, CFC 1998